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# Engineering News-Record

March 17, 1932

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## Demoralization in the Cement Industry

FIRST OF TWO ARTICLES in which the causes of the present competition and price collapse are analyzed as an introduction to a suggested realignment of production facilities which will constitute the second article.

First Long-Span Suspension Bridge Erected in Maine

Shallow Concrete Floors Developed for Philadelphia Schools

Rahway Tests of Activated Carbon Show Its Selective Nature

Automatic Parking Elevator Goes Into Service in Chicago

Wrought-Iron Piles Resist Seawater for Half a Century

Comparative Costs of Four Types of Road Surfaces

Stabilization of Rivers in India Compared With Mississippi River Work

Blade Spreading of Plant-Mix Bituminous Highway Surfaces

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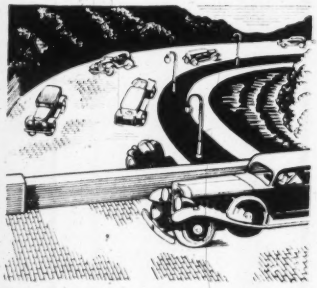

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F. E. Schmitt, Editor

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## Credit and Construction

"NO CREDIT expansion can help," said an eminent student of public affairs a few days ago, "unless the credit flows onward through the channels of business and produces employment." The truth of the remark is patent. Just now its application to our present troubles is under test. There are encouraging evidences of helpful effect of freer credit to banks and railroads, but as yet they are slight and scattering. It remains to be seen whether industry will increase its output or railroads their traffic before increased employment creates a demand for more goods and more freight. Construction, the key to this increased employment, is still at a low level. Until it expands and puts more men to work about the only thing that freer credit can do is to instil some confidence into those who have surplus money and thereby cause them to buy, invest and venture. Business rests largely on the buying ability of the employable masses, however, and their buying depends materially on whether construction is revived.

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## Bond Values

INHIBITIONS of the financial agencies which prevent sound bond issues for public works from finding a normal market are developing ingenious reasoning and devices for realizing cash to construct needed improvements and supply employment. Last week it was noted how the workmen of the Hetch Hetchy water-supply construction put up the margin which the bankers believed they should have in advancing cash for San Francisco city bonds. Now St. Louis county in Missouri is showing its taxpayers by comparative construction costs of today and two years ago when the bonds were authorized that they can obtain 60 per cent more work than was expected for their bond dollar, and that they can well afford to take a discount on the bonds and secure the improvements and earnings for their unemployed. The business soundness of the plan seems to find justification in the fact that a million and a half of road bonds have been sold for a discount of 1.85 per cent.

## Instructive Performance

DEMOLITION of several of the early skyscrapers within the past few years has revealed a gratifying excellence of the wrought iron and steel of which their frames were composed. To these service records is now added another for wrought iron, in the form of pipe piles standing in San Francisco Bay for the last half century. Salt water, accompanied by the rise and fall of the tide, imposes one of the most exacting set of conditions to which an engineering material can be subjected. Yet these piles after being removed are destined for further use elsewhere. Corrosion resistance has long been recognized as an outstanding characteristic of wrought iron. The significance of the San Francisco piles lies not only in their resistance to seawater but in their uniformity of corrosion. Lacking imperishability in a material, engineers can be well satisfied by a uniform and predictable rate of deterioration. Knowledge of such quality enables them to build safely and economically.

## Virginia Centralizes

VIRGINIA'S addition to the group of states that have taken over the roadbuilding work of townships and counties is an important step forward in the movement to simplify the overcomplex structure of local government. Road revenues and expenditures are the source of many troubles in town and county administration. The state collects the principal road revenues and also can expend them most efficiently. Division of the road system into separate jurisdictions was the logical and necessary thing in the early days, but now merits reconsideration. The distinction between federal-aid, state, county and township roads and city streets has become progressively more inconvenient. So we move forward steadily to the point where partial or complete unification appears the logical solution of the problem. The centralization movement which Virginia has just joined is therefore natural and in the interests of efficiency. It will unquestionably strengthen many weak elements of road construction and maintenance to the advantage of efficient road service.

## Centralization at Washington

GOVERNMENTAL simplification of another kind, the reorganization of federal departments to centralize functions, has a less obvious course to follow, and probably for this reason has become involved in political differences, both the President and the Congress wanting to control the reorganization. This disagreement, added to the fact that just now the government

has much more urgent work to do, makes the centralization attempt untimely. The structure of the governmental machine is notoriously haphazard and archaic. Departments and bureaus are arranged illogically, certain functions are needlessly dispersed, and an ever-increasing number of independent boards and institutions creates further confusion. Dozens of bureaus, for example, carry on survey and mapping work. Scores of bureaus are engaged in construction, and doubtless some of them would be better served by a central construction bureau, though certain present examples of centralized service are not encouraging to hopes of real efficiency through centralization. As a whole, reorganization presents a problem of such magnitude that a satisfactory solution can be reached only after thorough study and discussion. The prospective delay in carrying it out is therefore not altogether regrettable.

### *Clearing the Streets*

BEFORE the mechanics of modern urban existence can develop much farther a way must be found to clear our streets for freer traffic flow. This has been fully recognized in discussions of parking, of off-street loading and of street enlargement and several attacks have been made on the problem, but by and large it has not effectively been carried beyond two dimensions. Human beings could be made to live in three dimensions, but the automobile had to stay on the ground. Chicago now records a new attempt to develop vertical parking and thereby to make the automobile as much of a skyscraper occupant as the office worker. This attempt will have to overcome all the discouragements arising from the easy habit of stopping at the curb and jumping out; but it is promising in its simplicity and speed as well as in its space economy. Moreover, the Chicago Loop district is favorable to the trial, since street parking is virtually prohibited there. The installation will be worth watching; if it is a success in practice it will help measurably toward restoring full street efficiency.

### *Truck Mixers*

TRUCK mixer design apparently has ahead of it a problem of simplification and standardization. This is a natural stage in the development of a machine for a new purpose. Different inventive minds have seen the solution in a variety of drum forms, blade shapes and other mechanical details. Those whose memories go back to the beginning of mechanical mixing of concrete have a clear picture of the succession of mixer shapes and types that preceded the comparatively simple rotating drum with interior blades, upon which modern practice has settled. There were cone and double-cone, cylinder, and cube mixing drums with and without blades, and continuous, batch and gravity types in long procession. With established mixer practice as a foundation, the truck mixer has to a great extent escaped the necessity of similar cut-and-try evolution, but designs which differ essentially are being offered in considerable number to the concrete constructor. That they are leading to confusion was clearly brought out in papers and discussion at the meeting of the American Concrete Institute two weeks ago. It appeared that recent investigations are already at variance in regard to mixing periods required and to density and strength of concrete obtained with different types of truck mixer. It is possible that each of these types will produce satisfactory concrete but also possible that each requires to be handled differently. Experience and experiment need be extended to determine the facts. Truck mixing is a process of such potential value that simplification and standardization should be sought by every means.

## Enlightening Testimony

IN HEARINGS before a Senate committee at Washington last week the vital position of public work in the scheme of industrial balance was brought out with unusual forcefulness. Construction of improvements for the general public welfare, representing non-capital investment of labor, was clearly shown to be the necessary means of overcoming and indeed preventing the evils of unemployment and disrupted production. Both the present emergency and the long-time adjustment of the industrial system demand such utilization of public construction.

With respect to today's emergency, architects as well as engineers and contractors pointed to the current reduction in municipal and state public works as an event that threatens dangerous consequences; they joined in warning of an increase in unemployment serious enough to jeopardize business recovery. The prospective loss in public construction was placed at 1¼ to 1½ billion dollars, and the resulting idleness at a million workers—which would add ten per cent to the present number of unemployed. Economists agreed with these witnesses in holding that planned promotion of public works is the only available remedy.

Restoration of employment and purchasing power, which is the vital need of the times, is in fact hardly possible through industrial resumption alone. Industry is already overproduced and must wait on revived demand; it does not require new facilities, and were they to be provided they would merely increase the pressure to produce and to sell competitively, through the increased capacity and the increased investment to be paid for. Non-competitive and non-productive improvement work is the sole means of bringing about the increased employment on which the cycle of industrial activity is capable of being built up. And with slight change of statement this same relationship holds in times of normal activity, for the constant flow of surplus production into increased productive capacity must inevitably lead to economic unbalance and collapse unless prevented by the diversion of most of the surplus into public works.

From this simple statement of the intimate relation of public-improvement construction to national prosperity it becomes evident that the financing and planning of public works is a subject which claims most careful attention. It is equally clear that the sources of credit for public works must be free and adequate as well as sound. In this respect, however, a great deal of progress has yet to be made. Present methods of providing credit have proved themselves inadequate, as the course of events during the past year demonstrates.

A witness at the hearing testified to information that concerted action was taken by an investment bankers' association last summer to discourage the issuance of municipal bonds. It is to be hoped that the committee will fully investigate and seek to verify this surprising report. On the basis of the testimony one can easily understand why many municipal bond issues could not

be sold last fall, since present practice makes the investment banker an essential factor in bond distribution.

The report lends force to two proposals that were before the hearing: the one contained in the LaFollette bill, providing for federal loans to cities and states to finance public improvements; the other a proposal that a semi-public corporation be organized under government auspices to buy the bonds of cities and distribute them to investors. Either plan, it appears, would be capable of being operated soundly, and either one would eliminate the possibility of private interference with public-works financing.

## National Registration of Engineers

A NATIONAL system of registering engineers has been under discussion for some time past by representatives of state examining boards, and now appears likely to be put into effect soon. As planned, it provides for a central administrative organization to be known as the National Bureau of Engineering Registration, which—quite unofficially, that is, without warrant of state or national law—will issue certificates of qualification to engineers who can meet the educational and experience requirements set up by the bureau.

These certificates will correspond to those issued by state license boards, but will have no legal standing as substitutes for a state license. Rather, they will serve as evidence to any state board that an applicant for a license has definite qualifications concerning which it need make no further investigation in determining the applicant's fitness for license. By the development of reciprocal agreements it is hoped to grant recognized legal standing to the bureau's certificates in all states.

National registration of engineers by a widely recognized agency has much to commend it as a means of breaking down the artificial barriers to engineering practice set up at state lines by the present state license laws. National registration also will aid the engineer who is called to take up work far from his usual field of activity and removed from his normal range of acquaintanceship. Often such men find it difficult to obtain the necessary indorsements on an application for a state license in the new field of activity.

The committee of the National Council of Engineering Examiners which has laid down the organization plan for the new bureau looks forward to other uses for the bureau's certificates of qualification. It anticipates their use in meeting a large part of the requirements for admission to professional engineering societies, in meeting some of the basic requirements for higher college degrees, in seeking employment, and in seeking professional engagements. Greater uniformity in state license law requirements through setting up the bureau's requirement for certification as guide also is an objective. But these are all secondary objectives.

Regardless of their merit or lack of merit the fact should not be lost sight of that if the secondary objectives are brought into consideration at this early stage they may obscure the primary objective and may antagonize the very men whose support is needed to make the national registration plan a success. But if attention is concentrated on breaking down the artificial barriers at state lines through general acceptance of registration in the National Bureau, the bureau's position will be assured and many of the secondary objectives may be attained almost automatically by those who seek them.

## Psychological Competition

NO ONE familiar with industrial conditions can doubt that the demoralization of price and commercial practice which prevails in some key industries, and which is shown typically in the sketch of the cement situation published in this issue, must be charged essentially to inevitable factors of competition, or to what is traditionally called the law of supply and demand. But more than the normal forces of competition would seem to be operative when a large industrial group yields to the habit of selling below cost. Some peculiar elements of business psychology are evidently involved. What these elements are remains for the present an unanswered question. Until they are discovered and understood, the probability of periodic business instability will have to be reckoned with.

As outlined in the sketch, cement production has overexpanded. Not, however, because outsiders crowded into the field, failing to realize that it was amply served by existing producers; on the contrary, most of the new mills built during the last decade were erected by experienced cement manufacturers, men who well knew the difference between facilities and demand. With eyes open they overexpanded the country's cement-making capacity. And they doubtless knew that their plants, both old and new, would often or always have to work at part capacity, and that their manufacturing and selling policies would have to recognize this fact.

Apparently the fact was recognized during the period when the consumption of cement was on the increase. At any rate there was commercial peace in the industry, and the price remained at a normal level despite a 50 per cent excess of capacity over sales even in years of high consumption. But the prospect of a sharp decline of sales that arose a year ago brought sudden change; a price war of vicious intensity began, in which (as in some other wars) each participant claimed to be acting purely on the defensive. Whether aggressors or defenders, they continued the war through the year, and succeeded in donating some millions of dollars to the consuming public—the industry lost nearly 25 millions, it is said. And the war is still on.

Just why the sound business sense of the individual manufacturer that led him to follow a conservative business policy for years was disregarded at the opening of 1931 is not apparent. The relation of demand to capacity shifted only slightly from that which had prevailed during the two or three years just preceding, yet this shift was enough to bring about an upset. Probably the upset was primarily one of psychological balance rather than of commercial balance. And if this is so, correction of the unbalance may have to await a restored psychology in the industry rather than an equalization of production and consumption, which latter is not likely to be reached very soon.

Psychological influences on competition have played a large part in the business policies of the past year or more. They affect many industries, and are doubtless present in the field of construction as one of the causes of the destructive bid shopping of recent times. The large losses which they have brought to wide circles have been the prime motive for intensive studies of ways to limit competition by group action. Ultimate correction of the ills responsible for these losses may, however, prove to depend quite as much on the good sense and understanding of the individual as upon combination or group action.

# Building First Long-Span Bridge in Maine

## Waldo-Hancock suspension bridge features twisted-wire strand cables, Vierendeel-truss-type towers and continuous girder approaches—Footbridges used for cable erection

By D. B. Steinman and C. H. Gronquist
*Robinson & Steinman, Consulting Engineers, New York, N. Y.*

THE SUSPENSION BRIDGE with cables of shop-manufactured strands prestressed to a high elastic modulus is exemplified by five structures with spans from 800 to 1,300 ft. —the Cologne-Mulheim bridge in Germany, the Grand Mere bridge in Quebec, and bridges at Maysville, Ky., Portland, Ore., and Bucksport, Me., in this country, all built within the last six years. In this article D. B. Steinman, who has been identified with three of these bridges, expresses the belief that below a span length of 1,500 ft., twisted-wide strand cables are more economical and stronger than parallel-wire cables and that the advantages increase directly as the span length is reduced. If this be even approximately true, every bridge engineer should keep fully posted on this new development. The Bucksport bridge described in this article is the latest of the twisted-wire strand cable structures so far built. —EDITOR.

THE WALDO-HANCOCK bridge, spanning the main channel of the Penobscot River near Bucksport, Me., was completed and opened to traffic on Nov. 16, 1931. Of the suspension type, with a main span of 800 ft., it is the first long-span bridge in Maine. Also it incorporates a number of novel features in its design and construction. The main towers, of a new artistic type emphasizing horizontal and vertical lines, are upright Vierendeel trusses. Cables are composed of twisted-wire strands, new anchorage details and non-adjustable suspender connections are used, and continuous girders on flexible columns constitute the viaducts. Among the novel and interesting features of construction were the marking of cable strands before erection, the use of footbridges for strand erection, the use of a cardboard model of the rock foundation, the construction of the main pier foundation on irregular bare rock of steep slope, the building of the foundations during a Maine winter and the methods adopted for handling materials and construction under unusual and difficult local conditions.

The bridge is also notable for economy of design and construction. The original appropriation for the one bridge was found to be more than sufficient for the construction of two, and a second small truss bridge was subsequently authorized and is now under construction. Part of the original appropriation will still remain unexpended after both bridges are completed.

The Waldo-Hancock bridge was built as a toll bridge under a state commission with state funds and federal aid. Its west approach is close to the historic Fort Knox at Prospect, in Waldo County; and the east approach is on Verona Island, which is connected by a low-level bridge to Bucksport, in Hancock County.

### Tower design

Artistically, the character of a suspension bridge is largely determined by the design of the towers. In the case of the Waldo-Hancock bridge the rigor of the natural rocky setting, the stern lines of adjacent Fort Knox and the background of colonial architecture in the neighboring town called for something simple. An attempt, therefore, was made to secure an artistic effect with straight lines, by spacing, arrangement and proportions.

Fig. 1—Towers of Waldo-Hancock bridge approximate vertical Vierendeel trusses with vertical web members for architectural effect and some measure of additional rigidity.

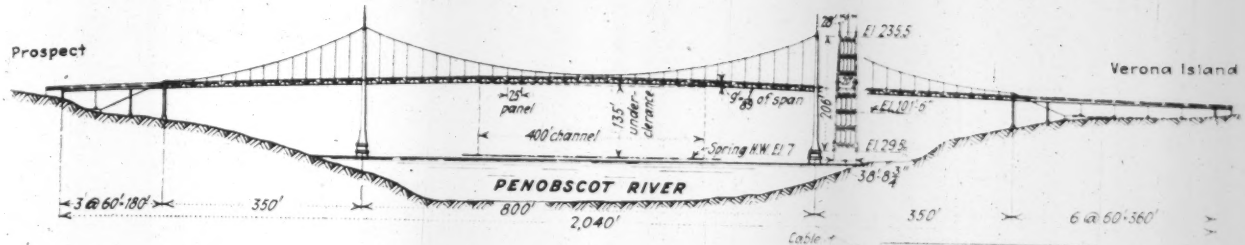
The towers, with respect to vertical forces and bending due to a definite longitudinal deflection, are designed in accordance with usual practice. With respect to lateral forces, they are designed as erect cantilever Vierendeel trusses, fixed at the base, with legs as chords and horizontal struts as web members. The light vertical members between struts were used primarily for esthetic purposes and were neglected in computing stresses, yet it is recognized that they add to the rigidity of the structure.

Further refinement in the design was deemed unnecessary since the unit stresses due to combined dead, live, temperature and wind forces were well within allowable unit stresses. The over-all dimensions of the tower legs were predetermined by requirements at the top to receive the saddle, by the batter and by the necessity of obtaining a reasonable $l/r$ ratio. The thicknesses of plates and angles were predetermined by standard requirements for such members in compression.

The use of horizontal struts therefore did not affect the design of the tower legs except for details. The tower legs are of conventional cellular type except that the inside or roadway face of the center cell is open to receive the horizontal struts and is battened between struts. This detail permitted the webs of the box struts to be connected directly to the sides of the center cell, which was very desirable in order to develop the full resistance of the strut in bending at this point of maximum stress and to transfer this bending directly to the main material of the tower leg. The roadway portal of a suspension bridge tower is naturally an indeterminate frame corresponding to a panel of a Vierendeel truss, and this adopted design merely extends the type over the remainder of the tower. The inside lines of the main tower legs were kept parallel, to carry out the vertical theme. The element of batter, artistically and structurally desirable, is supplied in the outer lines of the tower legs.

### Continuous viaduct girder

The approach viaducts consist of continuous girders supported on flexible columns, six continuous 60-ft. spans at the east end and three continuous 60-ft. spans at the west end of the bridge. Each continuous viaduct is fixed at the approach abutment, and all of the roadway expansion is concentrated at the cable bent. Provision for intermediate expansion movement is afforded by the flexibility of the supporting column bents. This continuous viaduct construction offers the advantages of a




more rigid structure, with reduced vertical deflections and increased longitudinal stability; it eliminates intermediate expansion joints, objectionable as a source of noise, unevenness and trouble in maintenance; it is economical, requiring less material in the girders and no high concrete piers; and it has the esthetic advantage of dispensing with the unsightly longitudinal bracing of the supporting columns.

### Twisted-wire strand cables

Following the precedent successfully established in other recent suspension bridges designed by Robinson & Steinman, prestressed twisted-wire strand construction was adopted in preference to parallel-wire construction for the cables. The newer cable construction offers economy in cost and time, while yielding greater strength with equal rigidity. The shorter the span, below an equal-cost limit of about 1,500 ft., the greater will be the economic advantage of the twisted-wire strand construction.

In the Waldo-Hancock bridge each cable consists of 37 strands, each $1\frac{3}{8}$ in. in diameter. The ultimate strength per strand is 216,000 lb., and it was prestressed to one-half of this amount to take out the non-elastic stretch and to raise the elastic modulus. The diameter of the completed cables is $9\frac{5}{8}$ in.

Each $1\frac{3}{8}$-in. cable strand is composed of 37 galvanized wires of No. 6 gage (0.192 and 0.194 in. in diameter), and six fillers of smaller galvanized wire (0.080 in. diameter). The strand is manufactured in two successive operations, the inner core of nineteen wires being first closed with 11-in. lay, and then the outer layer of eighteen wires being closed with $15\frac{1}{4}$-in. lay. The minimum value obtained for the modulus, after prestressing, was 26,600,000 lb. per sq.in., as compared with 24,000,000 specified.

At the request of the engineers the strands for the successive horizontal layers in the finished cables were made alternately right and left lay, so that wires in contact, receiving the bearing of superimposed stands, would be parallel instead of crossing at an angle.

From the rocker cable bents to the anchorages two additional strands are incorporated in each cable, thus providing for the proportionately greater tension in the backstays, without wasting material in the main lengths of the cable where the extra section is not needed. The extra strands also serve

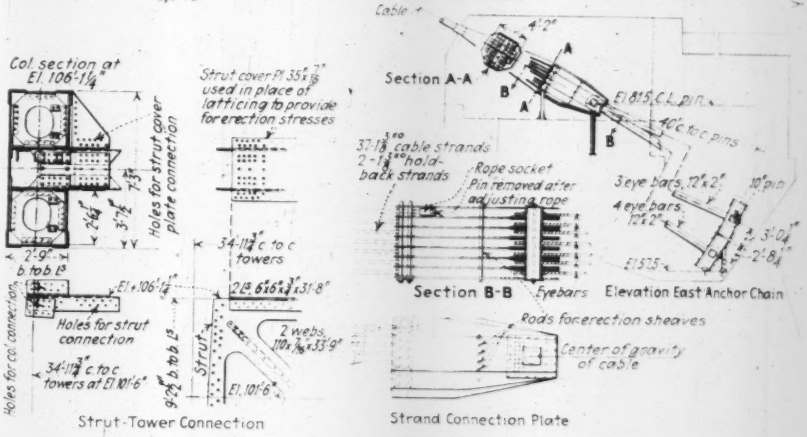

Col. section at El. 106'-1¼"
Strut cover Pl. 35½" x ⅞" used in place of latticing to provide for erection stresses
Holes for strut cover plate connection
34'-11⅞" c. to c. towers
Holes for strut connection
Holes for col. connection
34'-11⅞" c. to c. towers at El. 101'-6"
Strut
2 webs, 110 x ⅞ x 33'-9"
El. 101'-6"
Strut-Tower Connection
Section A-A
Cable
El. 81'-5" C.L. pin
40' c. to c. pins
37-1⅜" cable strands
2-1⅜" "hold-back" strands
Rope socket
Pin removed after adjusting rope
3 eye bars, 12" x 2"
4 eye bars, 12" x 2"
10" pin
Section B-B
Eyebars
Elevation East Anchor Chain
Rods for erection sheaves
Center of gravity of cable
Strand Connection Plate

Fig. 2—Structural details of Waldo-Hancock bridge in which the tower make-up and the simplicity of the anchorage connections for the strands are notable.

as "hold-backs," being positively anchored to the cable-bent saddles and resisting any tendency of the cable bents to kick forward under the unbalanced angles of the cable.

In the previous applications the twisted-wire strands had been furnished by John A. Roebling's Sons Co. For the Waldo-Hancock bridge they were fabricated and furnished by the American Steel & Wire Co. New modified anchorage details were developed for the strand assembly, and instead of long strand plates to accommodate hydraulic pulling jacks for adjusting each strand, as used on previous bridges, a few holes were provided for pinning a sheave at those points, the individual strands being adjusted by block and tackle.

A new experiment in cable construction was the marking of the cable strands before erection. At the time of measuring the strands for length at the shop and while in the prestressing machine with the load reduced to the calculated average dead-load tension, distinctive paint marks were placed on each strand to premark the saddle points, the center line of the main span and the cable-band locations, all carefully precalculated. In addition, each strand was marked with a continuous-colored stripe longitudinally, so that untwisting could be avoided or corrected. This premarking saved time and trouble in the field, and subsequent sag measurements showed that cables can be set accurately by such marks.

Fig. 3—Low flat arch for tower portal gives impression of width to the relatively narrow bridge (20-ft. roadway and 3½-ft. sidewalks). Vertical lines are emphasized by straight interior face of tower legs, vertical bracing members and suspender ropes. Wire-mesh rail guards provide adequate safety with light weight.

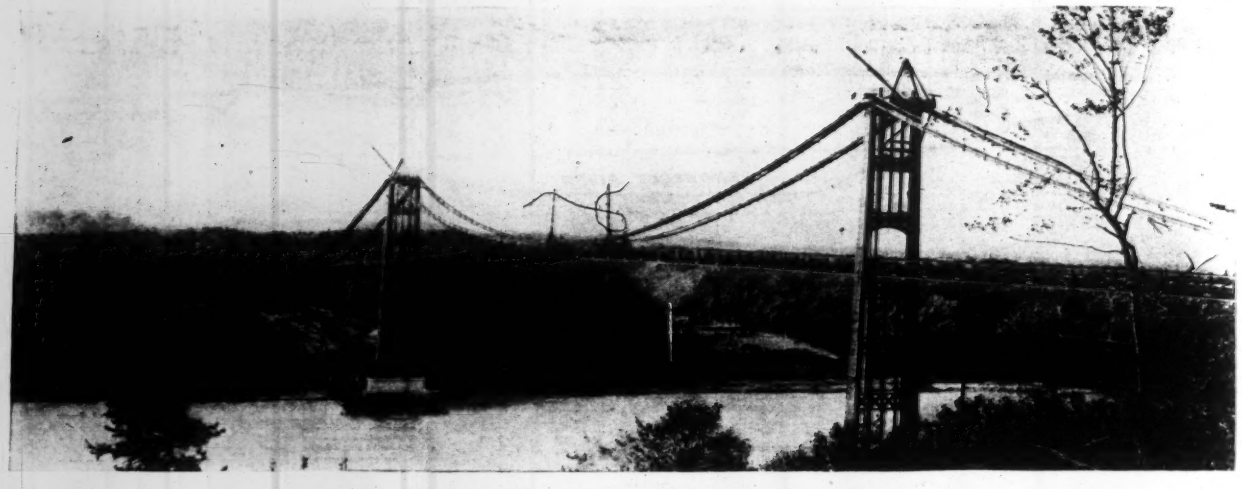


Fig. 4—Erection of the Waldo-Hancock bridge entailed the use of A-frame creeper derricks for the towers, gasoline-powered stiff-leg derrick travelers for the floor steel and light footbridges for cable-strand assembly and adjustment.

Another departure from precedent except for the Maysville, Ky., bridge under construction at the same time, was the use of footbridges in the erection of twisted strands. Only very light footbridges were required, but they facilitated adjustments and saved time in the various erection operations.

*Details* — Departing from customary practice, non-adjustable suspender connections were utilized, since suspender adjustments are unnecessary in a properly erected bridge and only invite subsequent tampering. The strand sockets are also different from the customary cast-steel sockets. They are made of rolled steel, square in cross-section, bored out to receive the strands, and the length is 4 in. greater than required for socketing, with transverse holes in the extension for a temporary bolt for erection purposes.

*Main Pier Design*—In the design of the main piers effective contrast was secured by using a plain concrete surface for the upper pier shaft and a granite facing below, the latter being required for protection against salt water and ice.

The top of each main pier was made concave to drain to a pipe at the center leading to a discharge below the water line, thus preventing disfiguration of the pier faces by rust streaks. The tops of both piers were bush-hammered to insure level supports for the tall steel towers.

## Construction procedure

The absence of roads, the roughness of the country, and the high steep river banks created special construction problems. Extensive dock work was required for handling the materials. All steel was received in barges and raised and moved to position by travelers operating on the bridge floor and on timber-trestle runways.

*Main Pier Foundations*—The construction of the two river piers was carried on throughout the winter of 1930-1931, requiring the heating of the concrete aggregates and the water, and the protection of the concrete and granite inside the cofferdams by means of canvas housing and artificial heat. These piers had to be constructed in an unusual range of tide (normally 9 ft. but often amounting to 14 ft.), coupled with a strong current. Single-wall open cofferdams of sheetpiling were used.

The base of the east pier is 34½ x 72½ ft. and rests on a firm foundation of clay, gravel and boulders at an elevation of 45 ft. below mean sea level. This base was made 23 ft. in depth to resist a full hydrostatic head when the cofferdam was unwatered, and was concreted during six days and nights of continuous pouring by means of a submarine bucket handled by a stationary derrick and fed by a concrete boat moored at one end of the cofferdam.

The west river pier was founded on irregular bare rock, extremely hard and on a steep slope. Very little blasting was required to secure proper keying of the foundation and to assure the security of the pier against sliding. A large model of cardboard laminations, reproducing close soundings over the foundation area at 6-in. intervals in both directions, was used to facilitate study of any additional rock excavation necessary. The cofferdam for this pier, 26½x72½ ft., was set around a timber frame of two ranges, supported and anchored by rockfilled timber cribs placed immediatedy upstream and downstream of the pier location as a measure of protection from ice and tide. The sheeting, driven around the cofferdam frame, was further secured by steel cables attached near the bottom of the sheetpiling and anchored to deadmen on the shore.

The pouring of the seal at this pier with the use of a tremie pipe resulted in the forming of practically no laitance. The tremie was handled by a lighter on one side of the cofferdam, the bucket was handled by the derrick on the concrete boat moored on the other side, and a stiff-leg derrick on shore fed the aggregates to the hoppers. Concrete for the two anchorages was mixed on the concrete boat and transferred by derrick and tramway to the point of deposit on land.

*Tower Erection*—The absence of diagonal bracing in the towers added somewhat to the difficulties of tower erection, special precautions being necessary to plumb the tower-leg sections accurately and to stay them until the closing transverse members were placed and connected. The lower 80 ft. of the tower and a 35-ton A-frame creeper traveler were erected by derrick boat, the remainder of each 209-ft. tower being erected by the creeper.

*Cable Erection*—The stringing of the strands for the cables was accomplished in two weeks, after the erection of the footwalks had been completed. These footwalks, 6 ft. wide, were made up of longitudinal planks supported on floor beams placed 8 ft. on centers and were suspended on wire ropes discontinuous at the main towers. In the main span each loop of rope passed around a sheave on the west tower and was fastened to turnbuckles on the east tower. Similarly the loops in the land spans passed around sheaves at the main towers, over sheaves at the cable bents and were attached to turnbuckles at the anchorages. After the footwalk ropes were in position, only 3½ days were required to place the footwalk sections themselves, the work progressing in both directions from each tower.

The main cable strands were hauled across the river on the footwalks by a continuous hauling rope passing through sheaves at the anchorages. Sheaves with side-plate guides were placed at the towers and bents, over which the hauling rope and strands were drawn. The strands twisted somewhat in hauling. These turns in the strands were removed to a maximum of four or

five in the total length of about 1,800 ft., after which the strands were picked up by hand and laid in the saddles without the use of gallows frames.

As stated, the shop marks were used in placing the strands in the saddles. An instrumental check of the position of the first four strands showed the shop-marking to have been so close that comparatively little change in the setting of these guide strands was necessary. The remaining strands were set and adjusted to lie parallel to the guide strands. In order to avoid overtime work and yet set the strands under proper weather conditions, the procedure used was to straighten the strands for a layer, place them in the saddles and adjust them during the day as well as the effect of the sun would permit. The next set of strands was then pulled across and laid on the footwalks but not in the saddles. Early the following morning before the sun had risen the position of the last strands in the saddles was observed, and the distances through which it would be necessary to move the strands to correct any discrepancies in adjustment were calculated. These changes were made by the workmen on their arrival at the usual hour in the morning. The subsequent wrapping from the footwalks was simple and fast.

*Floor Steel*—The erection of steel for the suspended spans was accomplished with the use of four deck-travelers working in both directions from the towers. The trusses were erected in 50-ft. or two-panel lengths. Riveting was commenced in the floor system as soon as all the steel had been erected. The truss splices, however, were fitted up whenever perfect holes occurred due to the passage of loads or to slight jacking and drifting, and this riveting was completed before pouring any of the roadway concrete. Such a procedure was possible because of the great flexibility of the 9½-in. cable and the shallow (9-ft.) stiffening truss.

*Cable Wrapping*—It was not considered necessary to delay the cable wrapping until all the dead load was on the bridge, and thus this operation was started at about the same time as the pouring of the roadway. In order to do the wrapping by machine the hexagonal-shaped cable was given a round form by the use of cedar fillers. The machine wrapping was done in three weeks, though the hand wrapping at the cable castings was slower.

*Time and Cost*—Construction commenced in August, 1930, and was completed in November, 1931, an elapsed period of sixteen months.

The original appropriation for the bridge, voted by the state legislature, was $1,200,000. The actual construction cost was less than $850,000. Of this amount the federal contribution was about $250,000, or one-half the cost of the superstructure. Taking advantage of the surplus funds an additional bridge was authorized to replace the existing old structure connecting Verona Island to the Bucksport shore. Estimated to cost $250,000, this contract was let for $151,000, of which one-half will also be a federal contribution. The surplus of the original appropriation will be used for road construction in the vicinity.

*Personnel*—The bridge was built under the authority and direction of a special commission of seven men, three of whom were members of the state highway commission. L. D. Barrows, chief engineer of the state highway commission, gave direct supervision to the project, assisted by Max Wilder, state bridge engineer. Representatives of the U. S. Bureau of Public Roads were G. H. Miller, R. S. Johnson and H. D. Fallon.

The bridge was designed by Robinson & Steinman, consulting engineers, New York, who were also engaged to supervise the construction and were represented by R. M. Boynton, in charge of the office work on the plans and specifications, and C. H. Gronquist, in charge of the field work as resident engineer, both reporting to William G. Grove.

The contract for the substructure was let to Merritt-Chapman & Scott Corp., and for the superstructure to the American Bridge Co.

# Demonstrating Bridge Stresses by Working Model

AN INSTRUCTIVE MODEL that makes the distribution and variation of stresses in members of bridge trusses clearly visible was exhibited by the Ohio highway department at the recent road show at Detroit, where it attracted much attention. It was developed by F. C. Nesbitt, designing engineer of bridges in the department. The members are made of metal bars interrupted by a short U-shaped bend near mid-length of the member, which bend opens or closes as the member is stretched or compressed by stress due to a load. The pointer of a dial gage is connected as a multiplying lever to a pair of sliding bars that extend across the open side of the U bend and indicates by the deflection of its pointer any opening or closing of the bend, and therefore the amount of stress set up by the load.

The working of the model has the merit of bringing out very clearly the rapidity with which stress increases and decreases in the different members, the progressive shifting of stress through the web, the reversal of stress in the web diagonals, and the direction of stress (tensile or compressive) in the several members. It has been found an effective means of making clear to the layman the reason for the form of bridge trusses and the manner of their action.

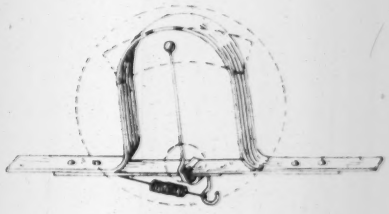


Fig. 1 — Stresses are indicated by a multiplying lever moved by the opening or closing of a U bend in the member.

Similar models are believed to be effective aids to school instruction. Suggestions have been made to the department that a number of such models should be built and distributed to engineering colleges, a matter now under consideration.

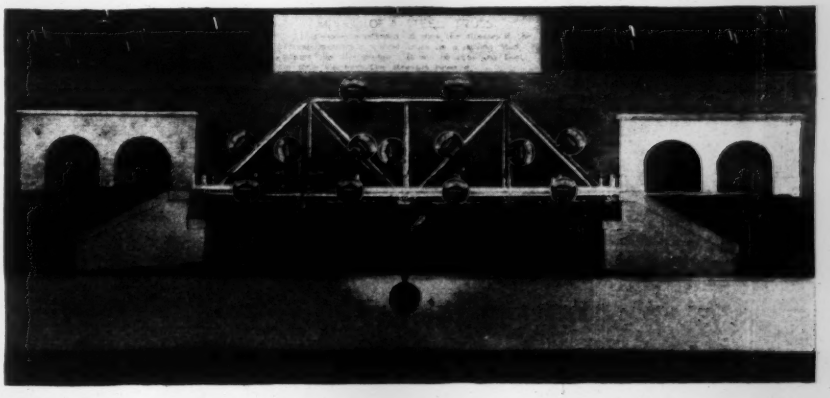


Fig. 2—Pin-connected Pratt truss model with strain-indicating gages inserted in each member was shown by the Ohio highway department at the recent Detroit road show. A vehicle running over the bridge shows, by pointers on dial gages, how the stresses increase or reverse in different members.

# Shallow Concrete Floor Developed for Philadelphia Schools

## Joists span 30 times their depth of 6½ in. with special joist over columns of same depth but 32 in. wide

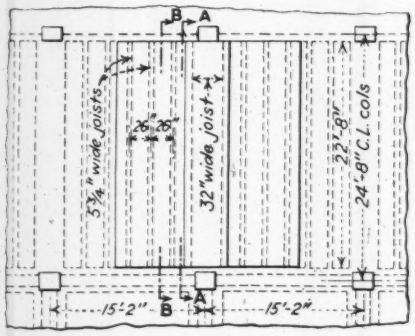
By Virgil L. Johnson
*Structural Engineer, School District of Philadelphia, Philadelphia, Pa.*

IN ORDER to eliminate deep girders in classroom ceilings there has been developed a novel concrete joist floor with maximum downward projections of 9 in. for use in Philadelphia school buildings. The floor consists of a 2½-in. slab supported on joists 6½ in. deep by 5¾ in. wide on 26-in. centers. The joists span the entire width of a classroom, or more than 30 times their depth, which is unusual considering that the maximum allowable span of a steel beam is 21 times its depth. In place of the deep girders over the columns, a joist with a total depth of 9 in. and 32 in. wide is utilized. This construction adds materially to the cubic contents of each room.

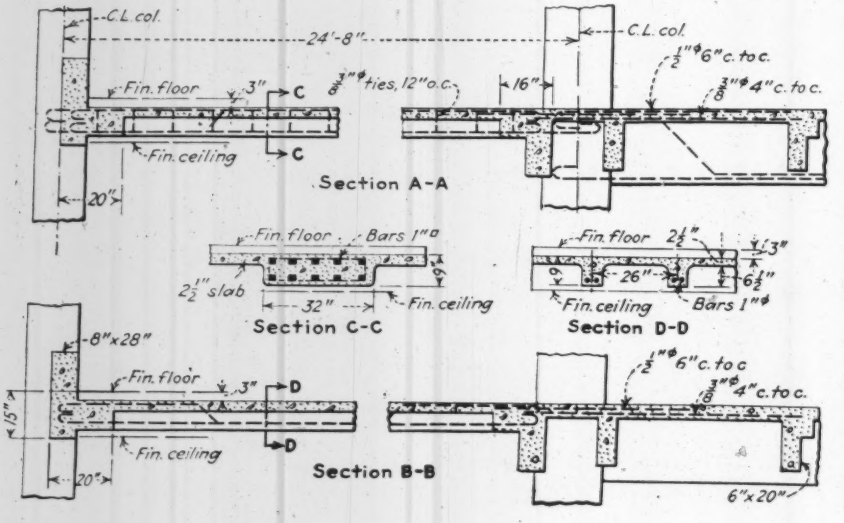
Since 1920 the Philadelphia board of education has used a reinforced-concrete skeleton frame for its school buildings. At first the floor construction used was formed of reinforced-concrete joists between fillers of hollow tile block covered with a 2½-in. slab. Later the hollow tile was replaced by sheet-metal fillers or permanent pans, and subsequently by removable heavy metal pans.

The size of a typical classroom used in these buildings is 23x30 ft., and since the column spacing is 15 ft. 2 in., there was exposed in the center of each classroom a large beam or girder running transversely across the room. This beam, projecting below the finished ceiling, was objectionable for several reasons. First, it was found to interfere with the distribution of heat; and second, its general appearance caused considerable criticism. The outstanding fault, however, was the difficulty of forming a permanent plaster bond on the sides and soffit of this beam. This could have been overcome with an incasement of wire lath, but because of the other objections to the construction it was decided to seek another solution.

Two school-building contracts were awarded in 1931, for a new elementary school at Twelfth St. and Columbia Ave., which we shall call type A, and the new junior high school at 59th St. and Malvern Ave., called type B. In both of these buildings the new slab design has been utilized to eliminate the center beam or girder projecting below the ceiling. This design, known as a 6½ plus 2½-in. slab construction, is only slightly deeper than the former system which required a 6-in. joist plus a 2½-in. slab. As stated, the former deep girders in the center of the classroom are replaced in the new construction by a joist 32 in. wide and 9 in. deep, spanning between the two center columns. The only beam visible below the finished ceiling is one parallel with and projecting 4 in. beyond the face of the rear wall or partition. This beam in the school type A will have a plaster bond, and in the school type B it will be covered with wire lath prior to receiving the plaster. Not only does the new design show economy in the elimination of formwork and plaster but there is also a reduction in dead load.




New shallow joist design for concrete floors developed for Philadelphia school buildings improves ceiling appearance and increases cubic contents of the rooms. Joints span 30 times their depth in some instances.




A test for strength and stiffness of this new floor construction was made on a classroom slab at the type A school with satisfactory results. The floor was loaded with twice the design live load of 50 lb. per sq.ft., and the greatest measured deflection under this loading was $\frac{5}{32}$ in., while the allowable deflection for a 1/360 span would have been $\frac{1}{10}$ in. The live load was removed 24 hours later, and all deflection was recovered.

Shallow construction and its corollary of increased cubical contents is an important economic factor in school-house design, requiring considerable study. This can be better understood by the following example: Considering the floor height to be 13 ft. 5 in. from floor to floor and the area 23x30 ft., the volume would equal 9,257 cu.ft. If the thickness of the floor construction is 13 in., this cubage would be 57½ × 13, or 747 cu.ft., leaving a net volume of 8,510 cu.ft. (It is to be noted that 57½ cu.ft. is the volume of a space 23x30 ft. in plan and 1 in. deep.) A volume of 8,510 cu.ft. will easily provide space for 42 pupils, allowing 200 cu.ft. per pupil.

If the floor construction is 20 in. thick, 1,150 cu.ft. (57½ × 20) should be deducted—thus leaving only 8,107 cu.ft. and reducing the pupil capacity to 40. In order to keep the pupil capacity to 42 per classroom, it would be necessary to increase the floor height from 13 ft. 5 in. to 14 ft. or to add more classroom.

From the above calculation it should be noted that, given a floor-to-floor height of 13 ft. 5 in. and a floor area equal to 23x30 ft., then 14.9 in. will be the maximum floor thickness for a classroom of 42 pupils.

The story height of 13 ft. 5 in. is used because the 7-in. stair riser is a multiple of that figure; the next available story height would be of course 14 ft. and then 14 ft. 7 in. It is obvious that the 13-ft. 5-in. story height with the least thickness of floor construction will give the lowest cost per pupil. The new shallower floor construction is thus seen to be a step in the right direction. Irwin P. Catherine is architect for the Philadelphia board of education, and the writer is structural engineer.

# Tests on Activated Carbon Show Its Selective Nature

**Medicinal odors effectively removed from Rahway, N. J., water at flow of 4 gal. per square foot per minute, while other odors remained—Pulverized carbon gave better results than granulated—Continued use of carbon decreases effectiveness**

By Mortimer M. Gibbons
*Supervisor, Water Filtration Plant, Rahway, N. J.*

DURING 1930 and 1931 experiments were conducted at the water-purification plant at Rahway, N. J., on the effectiveness of activated carbon in removing objectionable odors. Since the spring of 1931 powdered carbon has been used on a plant scale. It has been effective on vegetable odors but is difficult to wash out of the filters.

Both granular and pulverized carbon were employed in the experiments. The results generally indicate that the material is selective in its action, being most effective against medicinal odors. In using the granular form of carbon the rate of flow employed (4 gal. per square foot per minute through a bed 24 in. thick and 16 in. in diameter), seemed too high for satisfactory treatment of Rahway water.

Rahway's water supply is obtained from the Rahway River. Industrial wastes from organic chemical manufacture have frequently caused disagreeable medicinal tastes and odors in the supply. Algæ, particularly *Synura*, have occasionally caused objectionable tastes and odors in the treated water from the plant.

The purification treatment given the water includes coagulation with aluminum sulphate, preliminary aeration, sedimentation with a six-hour detention period, sand filtration, chlorination and final aeration. The effluent from the plant has had at all times a turbidity of less than 1 p.p.m.

The experiments with granular carbon were conducted in a gravity filter tank 16 in. in diameter and containing 24 in. of granular activated carbon (effective size 0.74 mm., uniformity coefficient 3.3) over 10 in. of gravel. This bed was operated with upward flow for the first three months, with downward flow during the succeeding eight months. The rate of flow was constant at 4 gal. per square foot per minute except for a period of two weeks, when a rate of 5 gal. per square foot per minute was employed.

Determinations of color, odor and residual chlorine were made daily on the influent and effluent; data for six typical runs are summarized in Table I. The carbon bed effected a large improvement in the odor of the applied water when the rate of flow was 4 gal. per square foot per minute, but it decreased in effectiveness when the rate was increased to 5 gal. The 4-gal. rate gave satisfactory odor removal under average conditions but was too high to effect complete decolorization and dechlorination.

To give an indication of the deterioration of the carbon in service, the results of odor removal under the worst conditions of the applied water are given in Table II. Six periods are considered. Medicinal odor was present on three occasions, and the carbon removed it each time. The effluent from the carbon bed had a woody odor on these occasions, much more pronounced in August than during February and March. This would appear to indicate that the adsorptive properties of the carbon had been reduced to some extent after eight months' service. The woody odor occurring on March 28 was reduced considerably but not eliminated. The bitter odor due to fermenting wastes was only slightly reduced by the carbon. The heavy vegetable odor in the water on Aug. 12 to 14 was removed satisfactorily. A cucumber odor, due to *Synura*, present in November, was reduced somewhat but was still strong enough to be objectionable.

These instances indicate that the action of the carbon in removing odor from water is selective, being particularly successful with medicinal odors. A rate of flow of 4 gal. per square foot per minute through a 24-in. bed seems too high for satisfactory removal of odor at all times from the water used at Rahway. Some revivification treatment would probably be necessary under these conditions about twice a year.

Activated carbon in finely pulverized form was applied to the raw water on a plant scale during November, 1930, to combat a cucumber taste due to *Synura*. About 200 standard units of *Synura* per cubic centimeter were present in the raw water. The carbon was fed through a dry-feed machine at the alum-application point, and mixing was obtained by passage through a centrifugal pump and 300 ft. of pipe line leading to the coagulation basins. The influent aerators were bypassed. The contact period of the carbon with the water was six hours. A dose of 3.5 p.p.m. of carbon was applied for two days. The cucumber odor was slightly reduced, but the final effluent was objectionable despite this treatment.

In the spring of 1931 regular treatment of the water with powdered carbon was started. The point of application of the carbon was changed to the coagulated water conduit entering the filters. A

TABLE I—EFFECTIVENESS OF CARBON CONTACT BED FOR SIX TYPICAL RUNS

| | Average Intensity Odor | | Maximum Intensity Odor | | |
|---|---|---|---|---|---|
| | Cold | Hot | Cold | Hot | Remarks |
| Influent | 1.8 | 2.3 | 2 | 3 | Jan. 8-27 |
| Effluent | 0 | 0.3 | 0 | 1 | Upward flow |
| Per cent reduction | 100 | 87 | | | 4-gal. rate |
| Influent | 2.0 | 3.0 | 2 | 3 | Feb. 28-Mar. 11 |
| Effluent | 0.1 | 1.0 | 1 | 1 | Upward flow |
| Per cent reduction | 95 | 67 | | | 4-gal. rate |
| Influent | 2.8 | 3.2 | 3 | 4 | Mar. 18-Mar. 25 |
| Effluent | 1.3 | 2.0 | 2 | 2 | Upward flow |
| Per cent reduction | 53 | 38 | | | 5-gal. rate |
| Influent | 2.0 | 2.5 | 3 | 4 | Mar. 28-May 7 |
| Effluent | 0.2 | 1.0 | 1 | 2 | Downward flow |
| Per cent reduction | 90 | 60 | | | 4-gal. rate |
| Influent | 1.5 | 2.1 | 3 | 3 | Oct. 28-Nov. 21 |
| Effluent | 0.2 | 0.9 | 1 | 2 | Downward flow |
| Per cent reduction | 87 | 57 | | | 4-gal. rate |
| Influent | 0.2 | 1.0 | 1 | 1 | Nov. 24-Dec. 12 |
| Effluent | 0 | 0.2 | 0 | 1 | Downward flow |
| Per cent reduction | 100 | 80 | | | 4-gal. rate |

TABLE II—EFFECTIVENESS OF CONTACT BED DURING PERIODS OF MAXIMUM ODOR IN APPLIED WATER

| Date, 1930 | | Applied Water Odor | | Effluent Odor | | Rate, Gal. Per Sq. Ft. Per Min. | Carbon in Service, Days | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | Cold | Hot | Cold | Hot | | | |
| Feb. | 1 | 3 woody<br>2 med. | 3 woody<br>3 med. | 1 woody | 1 woody | 4 up | 32 | Odor due to wastes containing phenols and aniline |
| | 2 | 3 woody<br>1 med. | 3 woody<br>2 med. | | | | | |
| Feb. | 6 | 3 bitter | 3 bitter | 2 bitter | 2 bitter | 4 up | 37 | Odor due to fermenting wastes |
| | 7 | 3 bitter | 4 bitter | 2 bitter | 3 bitter | | | |
| | 8 | 2 bitter | 3 bitter | 1 bitter | 2 bitter | | | |
| | 9 | 2 bitter | 3 bitter | 1 bitter | 2 bitter | | | |
| | 10 | 1 bitter | 2 bitter | 1 bitter | 2 bitter | | | |
| | 11 | 1 bitter | 2 bitter | 1 bitter | 1 bitter | | | |
| March | 18 | 3 woody<br>2 med. | 3 woody<br>3 med. | 2 woody<br>2 woody | 2 woody<br>2 woody | 5 up | 77 | Odor due to wastes containing phenols and aniline |
| | 19 | 3 woody<br>1 med. | 3 woody<br>2 med. | 2 woody<br>2 woody | 2 woody<br>2 woody | | | |
| | 20 | 3 woody<br>2 med. | 3 woody<br>3 med. | 2 woody | 2 woody | | | |
| Aug. | 12 | 3 veg. | 4 veg. | None | 1 veg. | 4 down | 224 | Odor due to decaying algae |
| | 13 | 3 veg. | 4 veg. | None | 1 veg. | | | |
| | 14 | 3 veg. | 4 veg. | None | 1 veg. | | | |
| Aug. | 24 | 3 woody<br>1 med. | 3 woody<br>1 med. | 3 woody | 3 woody | 4 down | 236 | Odor due to wastes containing phenols and aniline |
| Nov. | 1 | 1 cucumb. | 2 cucumb. | None | 1 veg. | 4 down | 304 | Odor due to *Synura*, approx. 200 units per c.c. in raw |
| | 2 | 2 cucumb. | 3 cucumb. | 1 cucumb. | 2 cucumb. | | | |

Only treatment given carbon occasional wash during this period was digestion with 2 per cent caustic soda for 48 hours on March 25-27.

suspension of carbon was fed through an eductor into the 30-in. influent conduit. The dosage varied from 0.5 to 2.0 p.p.m. The contact period of the carbon with the water was 20 min. This treatment improved the taste of the water by eliminating odors, due to vegetation growth. A woody taste believed to be due to chlorinated organic matter also was removed.

Increasing turbidity of the filtered water was observed in the six weeks that the carbon was applied at that point. It was thought that the agitation of the flocculated water immediately prior to filtration might be responsible, so the point of application of the carbon was changed to the entrance of the secondary coagulation basin. The change eliminated the increased turbidity. A contact period of the carbon with the water of nearly three hours is available.

Powdered-carbon treatment has been in regular use since that time. The dosage has varied from 1 to 8 p.p.m., averaging 2 p.p.m. The treatment has been successful in eliminating vegetable odors with the exception of those due to *Synura*. In November, 1931, *Synura* was present in the raw water for several days in concentrations of 100 to 200 standard units per cubic centimeter. A dose of 4 p.p.m. of carbon did not completely eliminate the cucumber taste. However, preliminary chlorination in conjunction with the carbon treatment removed it completely.

The effect of powdered-carbon treatment on sand filtration is worthy of consideration. Filter runs have not been appreciably shortened except when large doses of carbon, more than 5 p.p.m., have been used. At such times filter runs have been reduced as much as 50 per cent. But the carbon is not completely washed out of the sand with the wash-water velocity of 24 in. per minute.

When it has been necessary to employ large doses of carbon for several days in succession an increase in the initial loss of head of nearly 1 ft. has been observed. This has followed a 5-min. wash period. The carbon has penetrated the sand layer to a depth of about 6 in. in eight months. To remedy this condition it will be necessary to wash the top 6 in. of sand in a sand washer at least once a year. We have no data on the effect of wash-water velocities greater than 24 in. per minute in the process of removing carbon from the sand beds.

# Survey of Expansion-Joint Practice in Reinforced-Concrete Arch Bridges

By Elmer K. Timby
*Instructor in Civil Engineering, Princeton University, Princeton, N. J.*

TO OBTAIN an index of current practice in the design of reinforced-concrete arch bridges, where the floor load is transferred to the arch by spandrel columns or by transverse spandrel walls, a questionnaire was sent to each of the state highway departments in the United States. Thirty-six replies were received, enough to serve as a good index of current practice. A summary of the answers received is given in the accompanying tables.

These data reveal the following facts:

1. Forty-three per cent of the bridges built have a span of less than 100 ft.

2. Thirty-eight per cent have a span between 100 and 150 ft.

3. Eighty-six per cent are of the spandrel-column type, and fourteen per cent are of the transverse spandrel-wall type.

4. Thirty-seven per cent have expansion joints at the piers only.

5. Twenty-seven per cent have expansion points at piers and at the one-third points.

6. Twenty-one per cent allow for expansion at every spandrel connection.

7. Nine states (25 per cent of the replies), representing 44 per cent of the structures built, now prefer expansion joints at the piers only.

8. Eight states (22 per cent of the replies), representing 18 per cent of the structures built, now prefer expansion joints at piers and at the one-third points.

9. Five states (14 per cent of the replies), representing 14 per cent of the structures built, now prefer expansion joints every 30 ft.

10. Six states (17 per cent of the replies), representing 21 per cent of the structures built, now prefer expansion motion at every spandrel connection.

11. Seven states (19 per cent of the replies), representing 2 per cent of the structures built, have no general practice.

12. States representing 44 per cent of the structures built now prefer expansion joints at the piers only, whereas only 37 per cent of the structures built were constructed in this manner. This indicates a swing in favor of expansion joints at piers only.

TABLE I — EXPANSION JOINTS IN EXISTING BRIDGES

| Span, Ft. | Type: Spandrel Columns | Type: Transverse Spandrel Walls | Location of Expansion Joints: Piers Only | Piers and ⅓ Points | Piers and ¼ Points | Piers and ⅛ Points | Every 30 Ft. | Every Spandrel Connect. | Sub-Total | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 0–100 | X | | 24 | 23 | | | 5 | 15 | 67 | 84 |
| | | X | 8 | | | | | 9 | 17 | |
| 101–150 | X | | 23 | 18 | 7 | 5 | 6 | 4 | 63 | 73 |
| | | X | 2 | 8 | | | | | 10 | |
| 151–200 | X | | 13 | 4 | 2 | 2 | 1 | 6 | 28 | 28 |
| | | X | | | | | | | | |
| 201–310 | X | | 1 | | | 1 | 1 | 6 | 8 | 9 |
| | | X | | | | | | | 1 | |
| Sub-Total | X | | 60 | 45 | 9 | 8 | 13 | 31 | 166 | 194 |
| | | X | 11 | 8 | | | | 9 | 28 | |
| Total | | | 71 | 53 | 9 | 8 | 13 | 40 | 194 | |

TABLE II — PRESENT PRACTICE IN USE OF EXPANSION JOINTS

| Number of States | Location of Expansion Joints: Piers Only | Piers and ⅓ Points | Piers and ¼ Points | Piers and ⅛ Points | Every 30 Ft. | Every Spandrel Connect. | No General Practice |
|---|---|---|---|---|---|---|---|
| 9 | 85 | | | | | | |
| 8 | | 35 | | | | | |
| 1 | | | 2 | | | | |
| 0 | | | | 0 | | | |
| 5 | | | | | 27 | | |
| 6 | | | | | | 41 | |
| 7 | | | | | | | 4 |

13. States representing 18 per cent of the structures built now prefer expansion joints at piers and at the one-third points, whereas 27 per cent of the structures built were constructed in this manner. This again indicates a preference for fewer expansion joints.

14. States representing 21 per cent of the structures built prefer expansion joints at every spandrel connection, and 21 per cent of the structures built were constructed in this manner.

## Large Regulating Reservoir in Europe Placed in Service

In August of last year a large regulating reservoir at the headwaters of the Oder River in German Silesia near Ottmachau was placed in service. The reservoir is formed by a dam 6½ km. long and contains 240,000,000 cu.ft. of earth. The dam has a height of about 56 ft. and creates a storage of 5,100,000,000 cu.ft. of water. A power station is also included in the project. The reservoir is for flood control and for the regulation of the flow of the river, which, for eight or ten weeks during the summer, carries so little water as to make shipping difficult or impossible. The dam has been under construction since 1927 as part of the government's relief work for unemployment. The total cost is 55,000,000 marks, including the construction of the power plant and awards for land damages.

# Stabilization of Alluvial Rivers in India

## Observations upon the problems involved in checking the meanderings of rivers in alluvial plains as related to problems on the Mississippi

By Sir Gordon Hearn
Streatham, England
Formerly Chief Engineer, Indian State Railways

HOW TO KEEP the Mississippi from changing its course at will on the alluvial plain that forms the lower part of its valley has long been a problem of interest to many engineers in this country. Many theories as to how the river could be stabilized have been advanced, and not a few of them have been tried out. No one of them has proved entirely successful.

Similarly, in Europe and Asia engineers have struggled with like problems and have met with partial success, frequently by different methods of approach. Unfortunately, the distance between us or the dissimilarity of speech have prevented as full an exchange of views as is desirable. In a small way Sir Gordon Hearn, in the article that follows, attempts to correct some of the results of that condition. His observations should serve to re-emphasize the advantages to be gained from a fuller exchange of experiences and opinions.
—EDITOR.

ENGINEERS are prone to believe that the problems of their own country are unique because the particular conditions are exceptional. American engineers are probably convinced of this. Judge Harris Dickson in an article published some time ago in the *Saturday Evening Post* claimed that they are the best engineers in the world. Engineers of other countries may read this with a wry face. But I will say this: for many years I have derived great benefit from a study of the long and excellent articles written by American engineers. I have gathered many hints that I have been able to use. So I am impelled to make some return by recording my experiences on the great rivers of Bengal. There may be nothing new in the theories derived. Records of the behavior of the Mississippi must be much more complete than the records of the Indian rivers, flowing through a very densely populated country, the inhabitants of which have a fatalistic outlook that is unconsciously communicated to the few European engineers. At least, such records as are contained in this article may be corroborative of theories of those who engage in controversy as to the best method of training the Mississippi. That the records are not more complete is regrettable, but so far as they go they do not support the engineers of the Rhone and other European rivers when they suggest that the Mississippi should be trained to a straight course.

The Eastern Bengal Railway (Fig. 1) has its terminus in Calcutta, which is situated on the east bank of the Hooghly River. This river forms the tidal portion of one of the delta spills of the Ganges, the upper portion being called the Bhagirathi. It is a tradition that the Ganges once flowed in the course of these two rivers, and it is accepted that the Brahmaputra River, once flowing in a course to the east of Dacca, was diverted by a small cut made by a cultivator, and now flows well to the west of Dacca.

These and other drastic changes of course are perhaps not impossible, even if we may consider them improbable. Very considerable changes, however, are taking place, causing constant trouble to an amphibious railway like the Eastern Bengal.

Leaving out of consideration its branches to the south of Calcutta, the main line of that railway runs north, and about 120 miles from its terminus it crosses the Ganges by a bridge more than a mile long. At this point the drainage area is estimated at 365,000 square miles, and the discharge in high flood at 2,380,000 sec.-ft. The surface velocity attains 13 ft. per second, and the depth to which scour extends is 90 ft. below the surface. This is a superflood indeed! The banks are not protected by levees, and, in spite of the spills down the deltaic channels, the country is flooded far and wide. When the Ganges bridge was built grave fears were expressed that the river might take to its former course down the Bhagirathi and that Calcutta might be swept away because of the afflux caused by the obstruction of the bridge piers. But after thirteen years no danger of this sort has appeared, and no afflux is noticeable at the bridge. Indeed it has never been filled, and from two to four spans out of the fourteen spans of 345 ft. appear to be superfluous.

### River crossings a serious problem

The railway engineers have to wage a constant battle in this part of the world and, I fear, adopt the traditional British method of "muddling through." The Ganges bridge has removed the necessity for one ferry, but there still remain seven ferries on the Eastern Bengal Railway system. One point alone is stable, two are practically stable but involve occasional slight readjust-

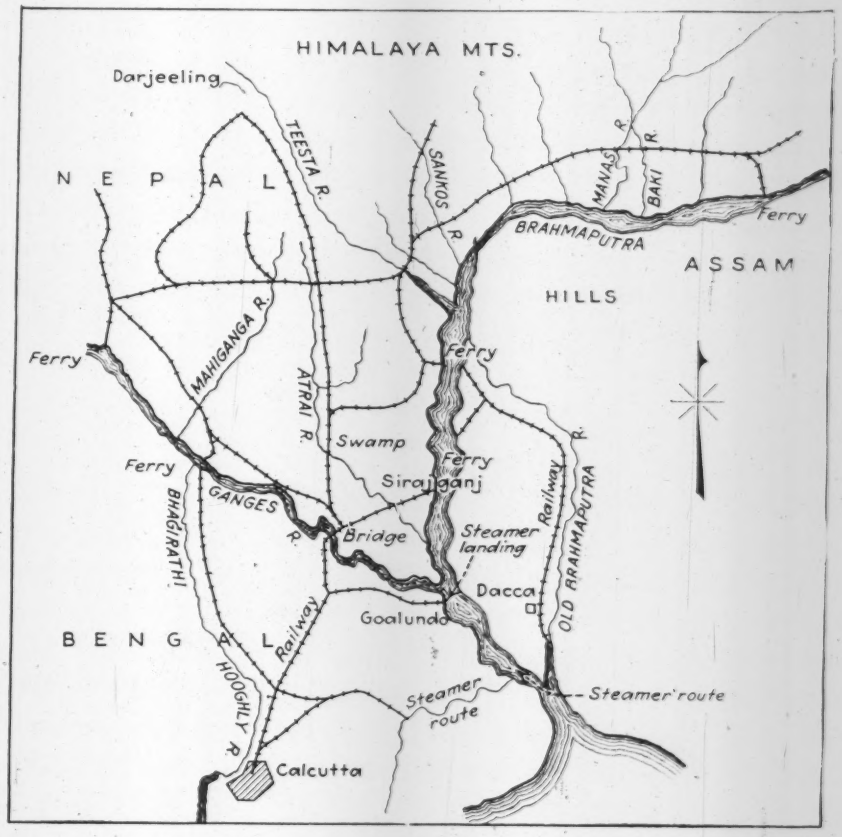



Fig. 1—Maintenance of the Eastern Bengal Railway is complicated by numerous crossings of unstable rivers.

ments. At seven shore landings it can never be certain that in a month or two a new landing point may have to be ready. It was in the endeavor to reduce the annual toll to be paid to the rivers that I investigated the possibility of finding some method in the madness of these rivers.

There are other landings which in a few years have had to be altered out of recognition. At that terrible place Goalundo, some years ago, permanent works were built for a permanent trans-ship landing place. The story goes that a dinner was in progress in Calcutta to celebrate the opening when a telegram announced that the rivers had had their dinner too. The site cannot be traced and never will. So nowadays the arrangements are temporary, the staff live in pole and mat huts, blown down in frequent squalls and cyclones and therefore costing a great deal in maintenance.

It might be thought that men who have spent years at this work would know a lot about the rivers, but they can only shake their heads and say that the rivers are all-powerful.

A solution of the problem of why the river changes its course would, it was hoped, enable the Brahmaputra to be "put into corsets," and substitute one permanent ferry for several shifting landing places, costing large sums annually in blackmail to that river. The problem was not quite the same as that of the Mississippi River, but it was just as necessary to try to judge what the behavior of such large rivers might be, and to determine to what causes this behavior was due.

The branches of the Eastern Bengal Railway cross many rivers of very respectable size, in particular a whole series on the branch leading to Northern Assam, as shown in Fig. 1. These rivers are crossed more or less at right angles to their courses, the soil is alluvial, and the behavior of these smaller rivers might be a guide to the vagaries of the large ones. They were far from stable. Some of them were giving trouble in consequence.

## River training at bridges

The accepted system in India for keeping a shifting river from leaving a bridge high and dry is to train it by stone guide-walls at the bridge. It is left to shift about as it pleases above and below. Some of the people lose their homes and their fields every year, but the river makes new fields and they move their temporary huts to another site. A fine crop of lawsuits may follow, but in Bengal lawsuits and building are national recreations.

These guide-walls are run out almost at right angles to the bridge for a length upstream of about the length of the waterway. They are very slightly splayed outward, the idea being to draw the stream together and to pass it through the bridge without unnecessary fuss at times of high flood. The stone walls are given a few feet of freeboard. The top ends are heavily armored with stone, which is taken right round the end and along part of the back, so as to make an impregnable head. The bridge piers are founded on wells, sunk to such a depth as to be safe from scour and to hold in the ground sufficiently to prevent tilting over and derangement of the superstructure. The downstream guide-walls may be curved outward.

The bed is expected to scour, and the armor on the slopes naturally would slip, exposing the soft core to erosion and destruction. An apron of calculated width and thickness is therefore laid at the foot of the guide-walls so that, after scouring, it may armor the whole slope to full scoured depth.

These rivers vary greatly in volume. During part of the year the volume is very small. Then comes the great heat, melting the snow on the lower slopes of the mountains and causing the rivers to rise. Then the rainy season not only swells the flood but also melts still more snow, and the volume becomes large. Perhaps one should say relatively large, for the maximum volume in the more important streams is only about 14,000 sec.-ft. The cross-fall is about 1 ft. in the mile, three or four times that of the Ganges or Brahmaputra.

## Characteristic river form

Such a river has a course like the track of a snake—that is to say, sinuous, in reverse curves. In the course of these rivers certain parts show a powerful erosion. The cross-section in a bend is triangular, deep water occurring along the concave bank. There is nothing new in these observations, but the point is that the bends appear to work downhill in homogeneous alluvial soil. Where today in plan the course has a bend to the right, ten or twenty years hence a left-hand bend appears in the same place. When, however, there occurs a hard deposit, the downhill slip cannot continue. The bend assumes a sharper radius, until the narrow neck on the convex side of the bend is cut through after a few years of high flood, and then no one can predict what course the river may take in readjusting itself.

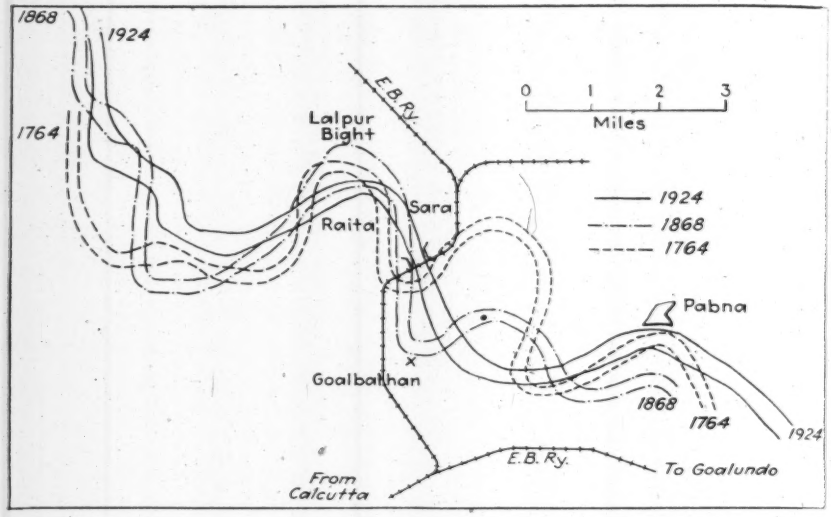



Fig. 2—In the neighborhood of the Eastern Bengal Railway crossing of the Ganges River the river has changed its course greatly in the past 160 years.

In general, in the conditions cited, a river carrying 14,000 sec.-ft. appears to adjust itself to bends of a radius of 2,000 ft. The Ganges appears to have a critical radius of half a mile. These radii are, however, the cutting radii and are not apparent at the highest flood in India, because the river is not confined by levees. It is not until the river has fallen "bank-high" that cutting occurs to any extent. No doubt some takes place in a rising river, but the critical period is then short, and the soil is dry or comparatively hard. When the river is falling, the process is slower and the soil is saturated, so that cutting is easier.

Almost certainly there is a hard spot somewhere, such as the clay bank occurring above the Ganges bridge. This bank was long considered unerodible, but subsequent experience has shown that it is erodible. It may or may not be possible for a river to erode a hard spot in time to avoid a cutoff; but if it cannot erode it, that point of deposit will for years form what I call a "node," or, as it is called in the Punjab, a "swing point."

It has been of great interest to me to study the map of part of the Mississippi, between Arkansas and Tennessee, given in the *Engineering News-Record* of Nov. 29, 1928, p. 802. It seems to me that in a period of years the river has swung right and left but has always passed through nodes at an average distance apart of 17,000 ft., a little more than 5 miles. The Ganges (Fig. 2) appears to have nodes at an average distance apart of 2½ miles. The mini-

mum is 1½ miles. Fig. 2 shows its courses in 1764, 1868 and 1924, the bridge having been finally provided with training walls about 1912. Islands are omitted, the courses being the main stream, so far as is known. The question of islands will be dealt with later.

The occurrence of nodes can hardly be due to hard clay deposits, although these exist at Raita and Sara. At both places the clay has been armored with stone, to form outlying training works. The tremendous bend below Sara in 1764 can only be accounted for by the necessity for the river to decrease its velocity after passing the Raita-Sara reach. Such great bends can be seen below Paris and London after the rivers have passed the defiles caused by cities, with their unyielding wharves and embankments. Or the bends of 1764 may have been due to a smaller discharge, due to a much greater spill down the Bhagirathi River.

As a great or a small river decreases in volume, it follows the rule of adopting a greater sinuosity with a smaller radius. The shrunken stream gives no real indication of the course bank-high in flood, or the limits of that course. Those limits will be shown by some of the islands, those standing highest above the bed. A cross-section that takes into account all the islands met with will give no true indication. Moreover, the bed itself may be silted up, although in some reaches the bed may be raised in flood time. If a cross-section is to be taken, it is best to search for a node, or swing point.

The reason for paying attention to the highest islands is that they are formed first and just outside the main current. As the river falls, the current swirls against the still water outside the main stream and forms backwaters. As the water flows upstream, it loses velocity and deposits its silt in islands. It will be observed that these are pear-shaped, the point being upstream. As the river falls farther, lower islands will be formed where there were none in high flood, to be scoured away probably in the next high flood. This scouring may also be the fate of parts of the high islands, and only a yearly survey can prove this. It is suggested that these high islands will give a good indication of what is likely to be the course of the river in the next flood.

### Stabilization of bends

What, then, is the conclusion to be drawn? If these nodes can be proved to exist, the river can be held at these points by stone guide-walls, or spurs if preferred, although the objection to spurs will be stated. A certain sinuosity for the river may be fixed. The alternative swing course may be closed, and for this the temporary spurs will suffice. Gradually then the convex bank at the bends can be advanced and land reclaimed, possibly paying for a good proportion of the cost of training. Part of the reclamation may be utilized for flood regulation, although these reservoirs will become silted up if not scoured out on a falling flood. Such work must take many years, for experiments must be made, but security of land tenure is worth attempting. Stabilizing one reach may have a good effect on several others.

The objection to spurs is that a scour hole forms below the spur, and this may run some distance. The straight stone guide-walls, in common use in India, always form these scour holes off the impregnable head. The scour hole often extends right through the bridge, causes slips of stone on the guide wall slopes and may even endanger the stability of the piers. It is particularly dangerous to align the bridge at an oblique angle to the general course of the river. The sinuosity works down and threatens the approach bank. A very deep scour hole forms off the training-wall head. Stone thrown in to fill the hole gets swept through the bridge, perhaps collects and causes a deep hole to form below the bridge and to work upstream. Such at least has been my experience. The Ganges bridge, by the way, is not at right angles to the general course of the river (Fig. 2).

It seems much more logical to curve the guide-wall to the critical radius of sinuosity, up to the point of reverse curvature shown by the sinuosity of the river. The wall may have to be curved through 120 deg., but often 90 deg. will be sufficient. The larger the river the shorter the guide will have to be. There will be no need for an impregnable head, and the apron can be shorter, for the stream will hug the wall instead of forming a scour hole. In order, however, to avoid attack, the distance between the guiding walls must be as small as the heart can be hardened to risk. Free scope for scour will do the rest in high flood, and the tendency to wander at the critical stage will be lessened.

It may be argued that contraction of the channel is not feasible, that these rivers want all of the existing wide channels and can at times easily fill them. But what appallingly bad conditions for free flow these channels present! Islands, scrub, broad stretches over which the water is shallow, all these tend to reduce the velocity and the flow. Then there is the question of the outfall into a shallow sea, with a deltaic bed continually advancing from the shore line. The solution of this problem presents considerable difficulty, but a contraction of the channel at the mouth may induce a scouring out and help the flow in the lowest reaches of the river.

# Silt-Sampling Apparatus Used on the Missouri River

By R. Whitaker
*First Lieutenant, Corps of Engineers, U. S. Army, Kansas City, Mo.*

THE SILT SECTION of the U. S. Engineer Office at Kansas City, Mo., which has engaged in silt studies continuously since May 8, 1929, has used two types of samplers for obtaining samples of suspended sediment, and two types of apparatus for obtaining samples of bed sediment.

The Au type U. S. Geological Survey silt sampler, used extensively on the Colorado River silt investigations by that department, was used throughout 1929 by this office. This sampler consists of a frame that holds a pint milk-bottle vertically. After the sampler has been lowered to the desired depth, a small drop-weight is allowed to slide down the suspending cable and strike a plunger, which drives a knife-edge cutter through the paper cap sealing the bottle and allows the water to enter. A float valve under the cap seals the bottle when about 400 c.c. of water has entered. This sampler has been discarded in favor of the Straub silt sampler, developed by the silt section of this office.

The Straub sampler, which has been used exclusively during and since 1930, is a development of the Au type sampler. It holds a capped milk-bottle vertically. A vertical spring holds the cutting plunger 1 in. above the milk-bottle cap. A small drop-weight is allowed to slide down the suspending cable and strike the upper end of the cutting plunger, forcing it through the cap. The spring then lifts the drop-weight and cutting plunger clear of the perforated cap, so that water can enter the bottle without obstruction.

A small hand-operated orange-peel bucket having a capacity of 220 cu.in. was used through the summer of 1929 to obtain specimens of bed sediment. However, this apparatus did not prove very satisfactory, as it required a launch and a large party for its operation and took considerable time to operate.

The Lugn cylindrical bed-sediment sampler has been used by this section since November, 1929. It consists of a cylinder that seats on a circular base, with a stem extending from the base through the cylinder. To operate the sampler a rope is attached to an eye in the stem and the apparatus is dragged along the river bottom from a bridge or small boat. The cylinder tilts down and cuts into the bottom material but seats on the base again and seals tightly when raised to the surface. The sampler is light and positive in action. It has proved very satisfactory.

# Automatic Parking Elevator Installed in Chicago

## New device is characterized by economy in ground area, speed of handling and elimination of attendance

INCREASING street congestion in all large cities inevitably leads to restrictions on length of parking time and consequent inconvenience for the motorist. Vacant-lot parking spaces are used in some cities, but in others some sort of a structure increasing the car capacity of the lot is necessary if the revenue is to be sufficient to pay taxes and yield a profit. Buildings served by both ramps and elevators have been developed and built. The parking machine described here differs from previous ones in that the cars remain on the elevator at all times. A minimum cost of operation is one of the requisites of any successful parking garage, so that the special automatic features of this new parking elevator are of particular interest and importance. —EDITOR.

TWO automatic-elevator parking machines for automobiles have just been placed in service in Chicago, this event marking the final commercial development of a conception that has been under trial for two years past at the works of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa,, where the device was evolved and perfected. Each of the two Chicago machines, which together form a double elevator structure combined in one framework, can receive and store 24 cars. The movement of the elevator machinery and the delivery of cars is entirely automatic and requires no human attendance.

The characteristic feature of the device is that on a ground space corresponding to two automobiles there are handled and stored 24 cars (or 48 on ground space of 32x24 ft., corresponding to four cars); and that receiving, storage and delivery are accomplished mechanically, without confusion or interference and very rapidly. The storage is secure, as operation is controlled by an attendant or a lock for each platform, and the car on a given platform cannot be taken out except by the possessor of the key controlling the operating button or switch for that platform.

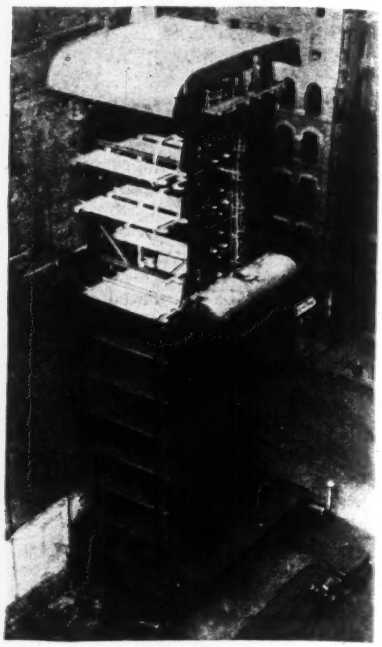


Fig. 2—Forty-eight automobiles are received, stored and delivered automatically by this double parking elevator just put into operation in Chicago. Total ground area is 32x24 ft.

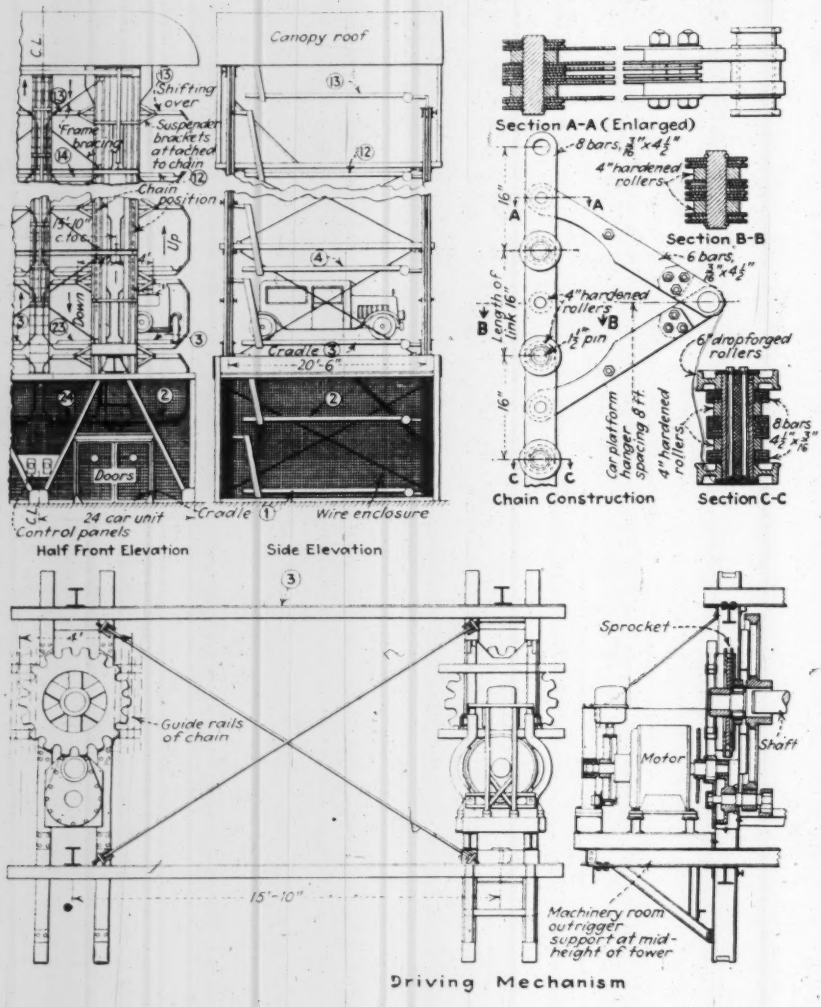



Fig. 1—Framing and operating mechanism of parking elevator. Car platforms are suspended at 8-ft. spacing from outriggers attached to a bar-link chain traveling between roller guides and driven by a sprocket at mid-height of the elevator.




Fig. 1 shows in outline elevation the double machine installed in Chicago, which is located in an open lot fronting on Monroe St. between State and Dearborn Sts. The supporting structure is a frame of columns, girts and bracing, whose function is to support the top or load-carrying sprocket and give rigid position to the vertical chain guides. The operating mechanism comprises two endless bar-link chains, one at the front of the machine and one at the back, the ascending and descending parts of which are spaced 4 ft. apart laterally. Brackets or outriggers attached to the links of the chain, projecting 2 ft. farther out from the center line, carry the attachment pins of the car platforms. Platforms are spaced 8 ft. apart vertically along the chains. The chain links themselves bear rollers of 6-in. diameter at the joints of the 16-in. links, these rollers traveling between rail guides; also 4½ intermediate rollers that are engaged by the supporting and driving sprockets. The driving motor and sprocket assem-

idly are mounted at half-height of the machine, which lessens the tension in the chain as compared with top or bottom drive.

Two ingenious features incorporated in the suspension mechanism of the car platforms increase the capacity of the machine and to steady it in operation, respectively. The first of these is the bracket arrangement, supporting the car platforms in a vertical line 2 ft. out from the center line of the chain itself; by virtue of this eccentricity the platforms move at double speed and spacing at the end of their travel, where they move in a semicircular arc, and thus the following car platfroms clear each other with smaller spacing than would otherwise be possible. The other feature is the vertical stagger of front and back chains and the corresponding stagger of the suspension points of the platforms. The forward chain is 7 ft. higher in elevation than the rear chains, and the pin that engages the hangar bracket is at the top of the platform frame; the rear or lower chain connects to a hangar

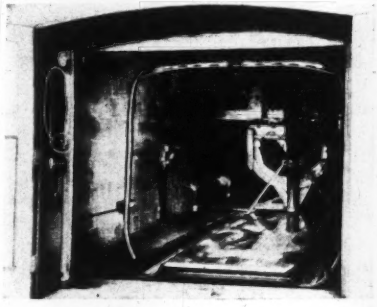


**Fig. 3—Platform of parking elevator is suspended at its top from the front chain and at floor level from the rear chain to check side-sway.**

pin at the level of the floor of the platform. Thus the line connecting the front and rear hangars, which is the swing axis of the platform, inclines downward from front to back, which checks any tendency to pendular swing of the platform as the elevator moves.

The principal features of the chain and hangar construction and the arrangement of the drive are shown in Fig. 1. The control, not shown, comprises a power-operated door-opening mechanism at the base or entrance, and a series of push buttons, or key buttons, with control-wiring system quite similar to that of apartment-house push-button elevators, but with one essential additional feature: when the operator (or car-owner) at the door of the machine, after he has closed the entrance doors, presses the button for a particular car—say car 8, which at that time is at some point other than the lower or access position—the elevator automatically assumes that direction of motion that will bring car 8 to the bottom by the shortest path. When the car arrives, the doors are automatically opened.

An operating speed of 100 ft. per minute is used. The maximum operating cycle (closing the door, bringing car platform to base, opening door) is 1½ min. The average time is 1 min. (50 ft. of travel). The dimensions of the double machine are 32x24 ft. in ground plan by 105 ft. high, and its weight is 132 tons. The drive is one 75-hp. direct-current motor for each machine. The cost of power for one complete car cycle (receiving, storing and delivery) is estimated at 3c.

Each automobile may be taken on and off the cradle by its own driver and not by a garage attendant. Electrical control apparatus locks the mechanism so that the chain of cradles cannot be operated while the garage doors are open or while any person is standing inside the inclosure.

A large garage will have control of operation by means of push-buttons in the cashier's office. A car to be stored is driven onto the platform at ground level after the entrance door has been opened by an attendant or by automatic means. When the driver has locked his car and come out of the inclosure, he operates the lever of a device that passes out a check stamped with the time and the number of the cradle. Its operation also puts the machinery in motion to raise that cradle and bring an empty one to the loading position. To take out his car, the driver presents his check and pays the charges to the cashier, who presses a button corresponding to the number of the check and thus causes the machine to operate automatically until that particular cradle is at ground level. The door of the inclosure then opens, admitting the driver, who unlocks his car and drives away. As the car passes out, it closes an electric circuit by which the doors are closed automatically behind it.

An alternative method substitutes a coin machine for the push-button control. For garages where cradles are leased by the month each tenant has a key, which he inserts in a slot to cause the machine to bring his cradle to the driveway level.

Construction of the machines involved complete assembly and matchmarking of the framework in the shop, with most of the shop connections welded and the field connections bolted. As a result, field erection proved to be rapid and simple. The Henry Ericsson Co., Chicago, was the erection contractor.

Development of this new device was carried out under direction of H. D. James, consulting control engineer of the Westinghouse company. According to Mr. James, the machine is not limited to a 24-car height, as higher machines (of correspondingly larger capacity) are possible without essential change of the structural or control parts, by providing additional drive units at suitable vertical spacing.

# Wrought-Iron Piles Resist Salt Water for 50 Years

## Supports for Fort Mason dock in San Francisco Bay show remarkable resistance to corrosion—Piles will be re-used after removal of structure

By O. W. Degen

*Civil Engineer and Superintendent of Construction, Quartermaster Department, U. S. A., Fort Mason, San Francisco, Calif.*

EXPOSED to sea water in San Francisco Bay for a half century, some wrought-iron pipe piles supporting the old Fort Mason dock No. 4 recently were removed when the structure was abandoned and were found to be in such an excellent state of preservation that they were placed back into service by the San Francisco park department in Marina Yacht Harbor. This type of dock was used in San Francisco Bay for structures built by the quartermaster department of the army during the early days, serving as important features of the military transportation system. The oldest dock of this type was built on Alcatraz Island in 1870. Although all of the structures have had occasional replacements of superstructure and decking, the substructures have never been touched even for maintenance. Five of the docks are still in active service; the Fort Mason structure was dismantled and removed to make way for a municipal harbor development.

According to available records, the Fort Mason dock was in service in 1884 and probably had been built a few years prior to that time. When dismantled it was the second oldest pier in the state still in service. The main structure was about 50x80 ft., with an approach section 20x100 ft. Depth of water along the outer face of the dock was about 21 ft. at low tide. The substructure consisted of 86 10-in. wrought-iron piles spaced about 10 ft. on centers. These piles were sections of pipe ½ in. thick connected by threaded couplings to provide the required length. Along the outer side of the dock some of these piles were 60 ft. long. The lower end of the pipe had a cast-iron tip bolted to the pipe and provided with a hole in the

Fig. 1—Type of wrought-iron pile and tierod substructure in use on Fort Mason dock, which has remained in service 50 years without attention.

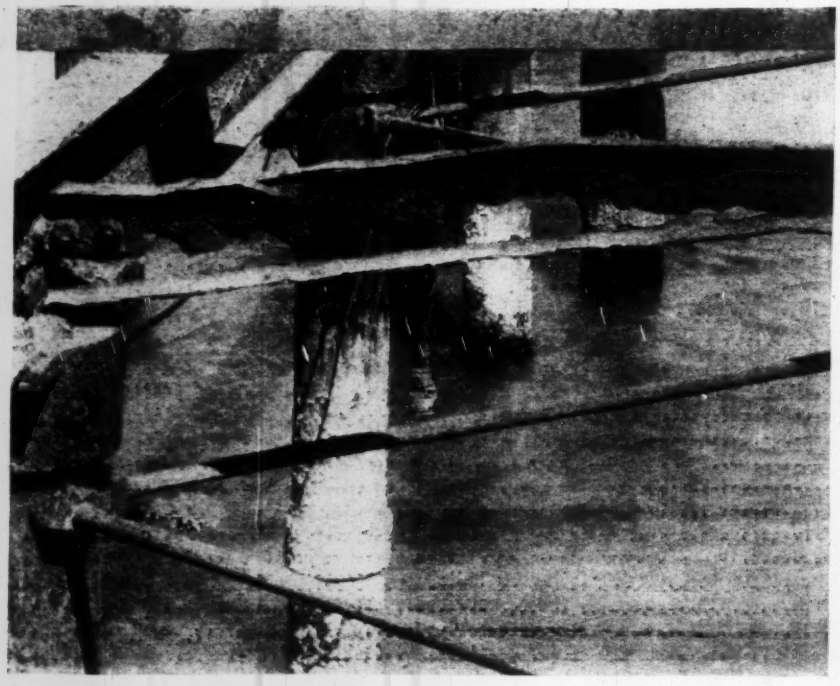
center that probably was used in jetting. From evidence and inspection at the time the piles were removed, they had apparently been driven and jetted to a depth of 20 to 25 ft. into the sand and silt of the bay bottom. The original superstructure was undoubtedly of timber construction.

There are indications from material adhering to the withdrawn piles that concrete was spilled around the outside when the piles were filled with concrete. Above mud level the longer piles were exposed to about 20 ft. of continuous submersion and a 6-ft. range of tide variation. The tide level came to within about 8 ft. of the superstructure.

When pulled each pile had a cast-iron cap, secured by four bolts, to hold the 12-in. steel I-beams of the superstructure in position and also to secure the cross-bracing system of 1¼-in. wrought-iron tierods (Fig. 1). The front of the dock was stiffened by 6-in. channels held in place by bands around each iron pile and a system of tierods. The condition of this steel superstructure, which has been in service only about twenty years, is clearly shown in Fig. 2. On top of the steel superstructure there were 4x12-in. fir stringers covered by a 3-in. deck. The dock had been in continual use up to the time of its dismantling.

The most remarkable information developing with the dismantling of the old structure was the excellent condition of the wrought-iron piles. Inspection showed them to be covered with a protective rust scale tightly adhering to the iron. Removal of this layer of scale indicated that the surface had corroded very evenly, leaving a full ⅜-in. average thickness of metal. There appeared to be no marked difference between corrosion that had taken place below low water, between high and low water, and above, where the piles were reached by spray. Particularly interesting was the difference in the form of scale on the piles and on the steel superstructure beams. The former appeared to be a slag coat forming practically a continuous tight skin, while the latter appeared as a flaky loose scale. The substructure was considered to be in first-class condition, and by replacing the steel I beam cap and braces it would have been good for another long period of service.

Fig. 2—Detail of dock structure before dismantling. Note tierod connections and condition of steel I-beam. Removal of tightly adhering scale on wet portion of wrought-iron piles disclosed uniform corrosion of about ⅜ in.



Upon removal and inspection, the city authorities, to whom the dismantled structure belonged, found that the condition of the piles made it feasible to place some of them back into service and to make use of others as pipe for the conveyance of a water supply.

During the writer's 26 years in his present office he has watched the condition of the structure closely. The resistance of the wrought-iron piles has been a matter of particular attention and has aroused considerable interest among visiting engineers. Further, it has been his observation that creosoted-timber fender piles require replacement after about ten years of service and that green piles have a life of approximately eight months under San Francisco Bay conditions, as a result of the ravages of teredo and limnoria. Taking the various factors into account, it is his opinion that the type of construction used for the old Fort Mason dock represents the most economical design for long-time service for ships of medium tonnage in water depths of about 20 ft. The proved resistance of the wrought-iron substructure and the ingenious method of bracing that provides ample rigidity are the important features.

The original cost of the dock was $27,555. Expenditures made during the life of the structure totaled $12,585, which was spent principally for woodpile and decking replacements.

## River Water Supplements Dresden's Groundwater Supply

Treated Elbe River water is being used to increase the groundwater supply of Dresden, Germany. The water is settled for four hours and then passed through rapid sand filters at a high rate. The filter effluent is sprayed through fixed nozzles onto sand beds, through which it passes into the ground. The rate of application is 54.75 gal. per sq.ft. per day. The aeration obtained reduces objectionable tastes and odors. The water is pumped from a line of wells around the sand beds, 212 ft. from the edge, the water reaching them in from five to twelve days. Subsequent treatment is utilized for softening and the removal of manganese.

# Strength of Corrugated Steel and Iron Sheets Reviewed

## Present safe-load tables based on formula published by Rankine in 1862—Difficult moment-of-inertia derivation necessary in using flexure formula

By Robins Fleming
American Bridge Co., New York, N. Y.

VERY FEW installations of corrugated-steel or iron sheets on roofs or walls of buildings have had the benefit of an analytical design. Usually empirical values for allowable span lengths taken from manufacturers' handbooks have been made to suffice. Yet there is a scientific basis for analyzing corrugated beams, as Mr. Fleming makes plain in this article. It is also true that the method of analysis is subject to numerous interpretations in several of its details, which is perhaps added reason why engineers should be more familiar with it.
—EDITOR.

AN EARLY REFERENCE to the strength of corrugated-iron or steel sheets was made by Rankine, in the first edition, dated 1862, of his "A Manual of Civil Engineering," in which he writes: "Corrugated iron in sheets is suited to bear light loads, provided the sheets are so supported that the bending action of the load takes place in a plane parallel to the ridges and furrows. . . . . Let $b$ denote the breadth of a sheet of corrugated iron, $t$ its thickness, $h$ the depth from ridge to furrow. Then its bending moment is approximately

$$4/15\ f_a\ h\ b\ t$$

$f_a$ being the modulus of rupture by crippling at the compressed part."

For a load uniformly distributed on a beam supported at the ends the maximum bending moment is $Wl/8$, $W$ being the load, in pounds, and $l$ the length of the span in inches. Hence $Wl/8 = 4/15\ f_a\ h\ b\ t$ from which

$$W = .32/15\ f_a\ h\ b\ t/l$$

From the date of publication until the present time the Rankine formula has been used almost exclusively for obtaining the strength of corrugated-steel sheets considered as beams. Different values have been assigned to $f$, and different ratios of safe to breaking load have been assumed. British texts: Molesworth's "Pocket Book of Engineering Formula" (1931) and Kempe's "Engineers' Year Book for 1930" give the transverse strength of corrugated iron to be $W = (44.6\ t\ b\ d)/l$ in which $t$ (thickness), $b$ (width of sheet), $d$ (depth of corrugations) and $l$ (length of span) are in inches. $W$, the breaking load, is given in tons (2,240 lb.) If in pounds, $W = (99{,}900\ t\ b\ d)/l$. Arrol's "Bridge and Structural Engineers' Handbook" gives $W = (99{,}000\ t\ b\ d)/l$.

The "Reference Book," (1930) of the American Sheet & Tin Plate Co., with a unit stress of $f = 12{,}000$, gives $W = (25{,}600\ b\ d\ t)/l$ in which $b$ = curvilinear width of sheet ($b = 1.075 \times$ formed width for 2½-in. standard corrugations). $W$ is the total allowable load on the sheet for length $l$. The Carnegie "Pocket Companion" gives the same formula. It is followed by scores of textbooks and handbooks. In some, 25,000 is used instead of 25,600, and in some $b$ is given simply as "width of sheet." It will be noted that 25,600 is obtained by multiplying the unit stress 12,000 by Rankine's factor 32/15.

The Pencoyd "Steel in Construction," discontinued in 1900, gave the formula $W = (98{,}000\ t\ b\ d)/l$, but made the serious error of calling $W$ the crippling load, in pounds per square foot. Hess, in the first edition of his "Graphics and Structural Design" (1913), makes the same error. In the second edition he changes the formula to $W = (100{,}000\ td)/L^2$ in which $W$ is the crippling load per square foot and $L$ is the length of span, in feet.

The fundamental formula for the flexure of beams is $M = fI/y$, $I/y$ being the section modulus, commonly denoted by $S$. The difficulty in applying the flexure formula to a corrugated-steel sheet considered as a beam is in determining the value of $I$, the moment of inertia. The curve of the corrugation may be considered either as the arc of a circle or the arc of a parabola. "Generally, in practice it is sufficiently close to consider a flat curve as a circular arc." (Swain, "Strength of Materials," p. 29.)

Rankine does not state how he derived his equation. However, the derivation may be found worked out in detail in Professor Humphreys' "Notes on Rankine's Civil Engineering." (Lexington, Va., 1894.) Considering the curve as the arc of a circle and the metal crossing the neutral axis at an angle of 45 deg., Professor Humphreys finds the value of $M$, the resisting moment, to be $4/15.2\ f\ h\ b\ t$. If the crossing is at 90 deg., he finds $M$ to be $4/16\ f\ b\ h\ t$; if at 60 deg., $M$ equals $4/15.4\ f\ b\ h\ t$; and if at 30 deg., $M$ equals $4/16.7\ f\ b\ h\ t$. "From which we see," he concludes, "that $4/15\ f\ b\ h\ t$ is a little too large and that $1/4$ is not a poor approximation."

*The Technograph*, "Selected Papers of the Civil Engineers Club of the University of Illinois," Vol. 17, 1902-03, has a paper "Strength of Corrugated Iron," by R. H. Gage. The curve of corrugation is assumed to be the arc of a circle with the metal crossing the neutral axis at an angle of 30 deg. From a painstaking mathematical analysis Gage finds the value of $M$, the resisting moment, to be $0.278\ f\ b\ h\ t$. If the crossing is at 45 deg., he finds $M$ to be $0.293\ f\ b\ h\ t$; if at 60 deg., $M$ equals $0.312\ f\ b\ h\ t$; and if at 90 deg., $M$ equals $0.393\ f\ b\ h\ t$. It will be observed that the constants are larger than the 4/15 (= 0.266) of the Rankine formula. Gage made several tests with concentrated loads on sheets 12 in. wide and 48 in. long supported at the ends on flat iron blocks. The results of his experiments agreed closely with his calculations.

Marks, in his "Mechanical Engineers' Handbook," gives the properties of a cross-section of "corrugated sheet-iron parabolically curved." (Third edition, 1930, p. 447.)

The section moduli used by the American Sheet & Tin Plate Co. (Table I) have been worked out in accordance with the formula given in the Marks handbook for a parabolic curve. The corrugations are assumed to be 2½ in. wide, with a mean depth of ½ in. The thicknesses are those of the Birmingham wire gage for flat-rolled steel. With the section modulus given, the strength can easily be determined from the fundamental formula $M = fS$.

Table II gives uniformly distributed loads that can safely be carried on corrugated-steel sheets simply supported at each end and is based on a unit stress of 15,000 lb. per sq.in. for bending. From the Rankine formula with this unit stress $W = (32{,}000\ b\ t\ d)/l$. The safe load, $w$, in lb. per sq.ft. for length of span $L$ in feet, may be expressed by

TABLE I—SECTION MODULI FOR STANDARD 2½-IN CORRUGATED SHEETS 1 FT. WIDE

| Gage No. | Thickness, In. | Weight, Lb. Per Sq.Ft. | Section Modulus In. |
|---|---|---|---|
| 12 | .109 | 4.94 | .1462 |
| 14 | .083 | 3.58 | .1270 |
| 16 | .065 | 2.90 | .0930 |
| 18 | .049 | 2.35 | .0735 |
| 20 | .035 | 1.81 | .0537 |
| 22 | .028 | 1.53 | .0437 |
| 24 | .022 | 1.26 | .0336 |

TABLE II—SAFE LOADS ON CORRUGATED SHEETS. (LB. PER SQ.FT.)

| Gage No. | Thickness, In. | Span 2'4" | 2'6" | 3'0" | 3'6" | 4'0" | 4'6" | 5'0" | 5'6" | 6'0" | 7'0" |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | .1072 | 428.8 | 274.4 | 190.3 | 139.8 | 107.0 | 84.6 | 68.5 | 56.6 | 47.6 | 35.0 |
| 14 | .0760 | 304.0 | 194.5 | 135.1 | 99.3 | 76.0 | 60.0 | 48.6 | 40.1 | 33.7 | 24.8 |
| 16 | .0613 | 245.2 | 156.9 | 108.9 | 80.0 | 61.3 | 48.4 | 39.2 | 32.3 | 27.2 | 20.0 |
| 18 | .0490 | 196.0 | 125.4 | 87.1 | 64.0 | 49.0 | 38.7 | 31.3 | 25.9 | 21.7 | 16.0 |
| 20 | .0368 | 147.2 | 94.2 | 65.4 | 48.0 | 36.7 | 29.0 | 23.5 | 19.5 | 16.3 | |
| 22 | .0306 | 122.4 | 78.3 | 54.4 | 39.9 | 30.6 | 24.1 | 19.5 | 16.1 | 13.5 | |
| 24 | .0245 | 98.0 | 62.7 | 43.5 | 32.0 | 24.5 | 19.3 | 15.6 | | | |
| 26 | .0184 | 73.6 | 47.1 | 32.7 | 24.0 | 18.3 | 14.5 | | | | |

$w = (32{,}000\ t\ d)/L^2$. Corrugations are assumed to be ½ in. deep, and the thicknesses are those of the U. S. standard gage, as given by the American Sheet & Tin Plate Co. for galvanized-steel sheets.

Table II may be used as a working basis for other data. If corrugations are ⅜ in. deep, as for the standard 3-in. corrugations used for export, the tabular loads should be increased 12½ per cent. If corrugations are ⅝ in. deep, the tabular loads are to be increased 25 per cent. The unit stress is arbitrarily chosen as five-sixths of the 18,000 lb. allowed for bending in the specifications of the American Institute of Steel Construction. When 12,000 lb. is required to secure necessary stiffness, the safe loads are 0.8 of those tabulated. For 12,000-lb. unit stress and corrugations ⅝ in. deep the table can be used without change.

Stiffness as well as strength is important. The deflection of corrugated-steel sheets under load can best be determined by tests. It is a matter of regret that so few recorded tests are available. Trautwine, in the first edition of his "Civil Engineer's Pocket-Book," bearing the date 1882, records "an experiment made by the author" of loading the center of a sheet of No. 16 corrugated iron 27 in. wide by 4 ft. long with 1,600 lb. of castings. This caused a deflection of ½ in. On the removal of the load after an hour no permanent set was appreciable. Trautwine considered the load he used equivalent to a uniform load of 1,335 lb. per sq.ft., and the deflection under such a distribution of load would be but ¼ in. The page of the first edition is given without change in all later editions, including the printing of 1929. It has been quoted a great many times during the past 50 years.

The authors of most books where the subject is mentioned are content to give something akin to the following: "Experiments have determined that corrugated sheet steel ⅝ in. deep and No. 20 gage, spanning 6 ft., will begin to give a permanent deflection with a load of 30 lb. per sq.ft. and will collapse under a load of 60 lb. per sq.ft. The distance between centers of purlins, therefore, should not exceed 6 ft. The common spacing is 4 to 5 ft. Since the corrugated steel on the sides of a building is subject only to wind load the girts may be spaced farther apart." ("Steel and Timber Structures." Hool and Kinne Series.)

The spacing of purlins and girts for corrugated sheet metal is somewhat empirical. Ketchum, "Steel Mill Buildings," specifies that roof purlins carrying a corrugated-steel roof without sheathing shall be spaced to carry a normal load of not less than 30 lb. per sq.ft. Girts for corrugated steel siding shall be spaced for a load of 20 lb. per sq.ft. The corrugated covering for many buildings will not figure for these loads. In many cases it is not necessary that it should. Where there is no snow load, as in most export buildings, a lighter roof load will suffice. In the common case of industrial buildings, with the slope of the roof 6 in. to the foot, the exposed surface is 1.12 times the projected surface. The load acts vertically, which gives a slight excess of strength over load figured normal to the roof for actual spacing. Again, corrugated-metal sheets usually extend over two purlin spaces and the fastenings tend to restrain the ends slightly. It is true that corrugated-steel figures for the light loads so often used will not allow a husky man to walk over without undue deflection; but is it always necessary that such provision be made? The spacing of roof purlins, the gage of steel to be used depend upon the quality of building desired. If the side covering receives only wind load, the unit stress for bending may be assumed at 20,000 lb. This assumption will increase the loads of the table 20 per cent. Specifications usually call for a wind load of 15 lb. per sq.ft. on the sides of mill buildings. Where sheet metal is used for siding there is little resisting force in the dead weight and 20 lb. is preferable.

# Comparative Costs of Four Types of Road Surfaces

## Charts showing accumulated costs per mile per year for gravel, gravel surfaced with asphalt retread, asphalt retread and paved-road surfaces

By W. W. Zass

*Construction Engineer, Arkansas Highway Commission, Little Rock, Ark.*

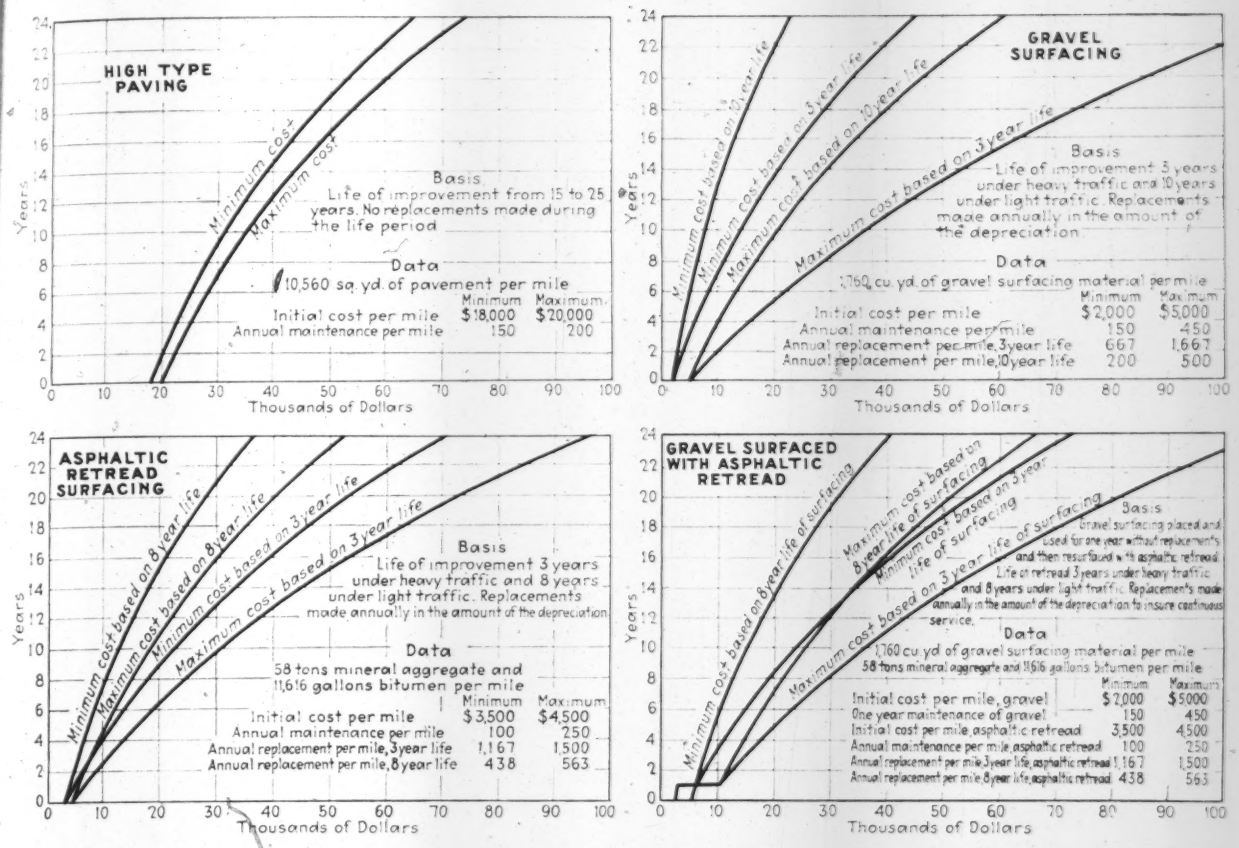
THE QUESTION is often raised as to the comparative cost of different types of surfacing. Although no direct solution of the problem is possible, we can approximate an initial investment per mile for each type considered, a normal annual maintenance charge, an assumed interest charge on the funds disbursed, and so presume, or predicate, the life or years of service of the improvement. An ultimate cost may thus be computed for each type, and the economy of the various types may be compared on the basis of such results, or the comparison made on the basis of the ultimate cost converted to a value normally termed the present worth, i.e., the present-day or discounted value of an amount due or payable in the future.

Any exact comparison of this nature is questionable and dependent on the value of the various factors involved, which are in turn dependent on the particular conditions existent in the section or locality in which the work is undertaken, such as labor and material prices entering into the first cost and the density of traffic entering into maintenance charges, as well as the ultimate life of the surfacing. Climatic, soil and drainage conditions are also pertinent factors tending to affect the various costs involved. Interest charges should of course be predicated upon the current rate existent in such localities for financing the type of work in question.

The costs per mile, both construction and maintenance, for the different types of surfacing indicated by the various charts cover such charges as refer to paving and surfacing items only; the various auxiliary work relating to and incident to the paving and surfacing operations, such as grading, drainage, warning signs and like items, are considered as common to each and therefore not included.

Annual maintenance charges, in the instance of high-type paving, include center marking, pouring cracks and joints and patching small areas. Such charges in the instance of gravel surfacing include blading, both as to equipment costs and operations, of heavy-traffic roads once per day and of light-traffic roads three times per week, and the patching of small areas; but they do not include replacements required for losses in material due to the wear of traffic or the action of the elements. Maintenance charges in the instance of asphaltic-retread surfacing include the patching of small defective areas only, and not replacements of material required due to disintegration under traffic over a prolonged period. In the matter of replacements it is considered that if the life of the improvement is assumed at three or eight or ten years, a replacement is made annually in the ratio of ⅓ or ⅛ or 1/10 of the initial construction, thus providing an unimpaired continuity of surface equal in condition to the improvement as first constructed.

The curves are based on minimum and maximum conditions, minimum initial costs being grouped with minimum maintenance charges, while maximum initial costs are grouped with maximum


HIGH TYPE PAVING
Minimum cost
Maximum cost
Basis
Life of improvement from 15 to 25 years. No replacements made during the life period
Data
10,560 sq. yd. of pavement per mile
Minimum Maximum
Initial cost per mile $18,000 $20,000
Annual maintenance per mile 150 200
Years
Thousands of Dollars
GRAVEL SURFACING
Minimum cost based on 10-year life
Minimum cost based on 3-year life
Maximum cost based on 10-year life
Maximum cost based on 3-year life
Basis
Life of improvement 3 years under heavy traffic and 10 years under light traffic. Replacements made annually in the amount of the depreciation
Data
1,760 cu. yd. of gravel surfacing material per mile
Minimum Maximum
Initial cost per mile $2,000 $5,000
Annual maintenance per mile 150 450
Annual replacement per mile, 3-year life 667 1,667
Annual replacement per mile, 10-year life 200 500
ASPHALTIC RETREAD SURFACING
Minimum cost based on 8-year life
Maximum cost based on 8-year life
Minimum cost based on 3-year life
Maximum cost based on 3-year life
Basis
Life of improvement 3 years under heavy traffic and 8 years under light traffic. Replacements made annually in the amount of the depreciation
Data
58 tons mineral aggregate and 11,616 gallons bitumen per mile
Minimum Maximum
Initial cost per mile $3,500 $4,500
Annual maintenance per mile 100 250
Annual replacement per mile, 3-year life 1,167 1,500
Annual replacement per mile, 8-year life 438 563
GRAVEL SURFACED WITH ASPHALTIC RETREAD
Minimum cost based on 8-year life of surfacing
Maximum cost based on 8-year life of surfacing
Minimum cost based on 3-year life of surfacing
Maximum cost based on 3-year life of surfacing
Basis
Gravel surfacing placed and used for one year without replacement, and then resurfaced with asphaltic retread. Life of retread 3 years under heavy traffic and 8 years under light traffic. Replacements made annually in the amount of the depreciation to insure continuous service.
Data
1,760 cu. yd. of gravel surfacing material per mile
58 tons mineral aggregate and 11,616 gallons bitumen per mile
Minimum Maximum
Initial cost per mile, gravel $2,000 $5,000
One year maintenance of gravel 150 450
Initial cost per mile, asphaltic retread 3,500 4,500
Annual maintenance per mile, asphaltic retread 100 250
Annual replacement per mile, 3-year life, asphaltic retread 1,167 1,500
Annual replacement per mile, 8-year life, asphaltic retread 438 563

**Charts showing comparative costs of road surfaces. Except as noted, interest on initial cost, annual maintenance and annual replacement charges are compounded annually at 5 per cent. Salvage value at any period is equal to initial cost.**

maintenance charges. Variations in these assumed conditions will produce a curve lying in the area between the minimum and maximum curve shown. The present worth of the ultimate cost at the end of any period of years may be obtained by the formula $P = (1 + r)^{-n}$ where $P$ = present worth of \$1, $r$ = rate of interest compounded annually, and $n$ = length of period in years. The factors obtained by this formula for various periods, with an interest rate of 5 per cent, are as follows:

| 5 Years | 10 Years | 15 Years | 20 Years | 25 Years |
|---|---|---|---|---|
| 0.7835 | 0.6139 | 0.4810 | 0.3769 | 0.2953 |

From the present worth of the ultimate cost should be deducted the present worth of the salvage value assumed at the end of such period, the net difference representing a money value per mile that can be used as a basis of comparison with other values similarly obtained.

### Illustrating examples

The comparison of cost between a high-type pavement and an asphaltic-retread surfacing constructed on a gravel base may be cited as an example. Considering a useful life of twenty years for the former, the ultimate cost at the end of such period amounts to \$56,500, averaging the minimum and the maximum. Considering the salvage value at the end of the twenty-year period as 25 per cent of the initial cost, an average salvage value of \$4,750 is obtained. The present worth of the ultimate cost is \$21,295 and of the salvage value is \$1,790, the net difference approximating \$19,505 per mile, such a total representing the comparative cost, including all charges, of the high-type pavement.

At the end of a twenty-year period the ultimate cost of the asphaltic-retread surfacing on a gravel base amounts to \$57,000, averaging the minimum and maximum of the three- and the eight-year life period, with a salvage value of both the surfacing and the base of about \$7,500, averaging minimum and maximum first costs. The present worth of the ultimate cost is \$21,483, and of the salvage value is \$2,827, the net difference approximating \$18,656 per mile, such a total representing the comparative cost, including all charges, of the asphaltic-retread surfacing on a gravel base.

Therefore, in so far as actual monetary disbursements are concerned, the comparative cost of the two types of surfacing considered in the example cited and for the values assumed would be approximately similar, the one type embodying a high initial investment with low carrying charges, and the other type a low initial investment with high carrying charges. In this instance, as in others, the comparison thus made should receive further consideration in regard to differences in operating costs of vehicles occurring on the types of surfacing in question, as well as to the ease and luxury of travel on such types, and also as to the funds available for initial construction expenditures.

## French Waterway Traffic Shows Increase

Freight traffic on the waterways of France increased nearly threefold in nine years, from 20,000,000 tons in 1921 to 53,000,000 tons in 1930, according to J. R. Frey in *Zeitschrift für Binnenschiffahrt*. This is placed at 16 per cent of the railroad freight traffic. In comparison, waterway traffic in Germany is estimated at 24 per cent of railroad traffic, with substantially the same mileage about 7,500 miles. However, of the French system 43 per cent is formed by canals, while the German system comprises only 18 per cent of canals, a comparison which suggests that natural waterways are more attractive to freight transportation than canals. Most of the French canal system has only 6½ ft. depth and is limited to 280-ton barges, while some canals will take only 80-ton barges.

# Plant-Mix Bituminous Surfaces Spread by Blading

## Oregon experiments indicate feasibility of laying stiff, plant-mixed bituminous surfacing with spreader boxes and graders

By R. H. Baldock
*Assistant State Highway Engineer, Salem, Ore.*

TO DETERMINE the most stable bituminous road-surfacing mixture that can be laid with grader equipment, a series of experiments was conducted in the fall of 1931 by the Oregon state highway department in the vicinity of La Grande, in the northeastern part of the state. The growing tendency toward plant-mixed surfacing for highways in the Western states introduces the problem of securing the most stable product that can be distributed and spread without using machine finishers supported by headers. The more stable and better proportioned plant-mixed material approaches the maximum of economy when its properties still permit laying with grader equipment. It has long been the opinion of the writer that as heavy an asphalt as possible should be used in obtaining the most permanent plant-mix bituminous wearing surface.

Existing practice with the plant-prepared product using the lighter oils generally involves mixing broken stone or gravel passing the 1-in. circular ring (50 to 60 per cent passing the ¼-in. screen) with from 4 to 6 per cent of 60 to 70 per cent asphalt road oil. This type of mixture is usually laid by road equipment including spreader boxes and blade graders. More recently a cutback asphalt has been used as a binding agent in certain instances. The presence of moisture in the stockpiles made drying stone necessary and the plant therefore included all the units required to manufacture the more stable types of asphaltic concrete. To the writer's knowledge no attempt had ever been made to determine the most stable mixture that can be produced by this method or to lay low-penetration asphalt mixtures with graders. The advantage of being able to spread the mix with road equipment as compared with finishing machines used for asphaltic concrete is obvious.

Material for the experiments consisted of road metal up to 1 in. size graded to a standard asphaltic-concrete specification. This material was heated and mixed with one of the following: (1) 95 per cent road oil, (2) 130-15 grade asphalt or (3) 50-60 penetra D grade asphalt. These various tures were spread with a standard s spreader, followed by strikeoff wi motor grader. The truck was dr carefully to a line marked by s wires attached to iron pins. The of the surfacing was afterward r up by shovels and hand tamped 45-deg bevel.

The E grade asphalt and the 95 cent road oil mixtures were heated temperature of from 180 to 190 deg. the grade D or 50-60 penetration as mixtures were heated to a temperat of 250 deg. F. Air temperatures var between 50 and 80 deg. F.

All of these mixtures spread ea and were struck off without difficu with the exception of the 50-60 p

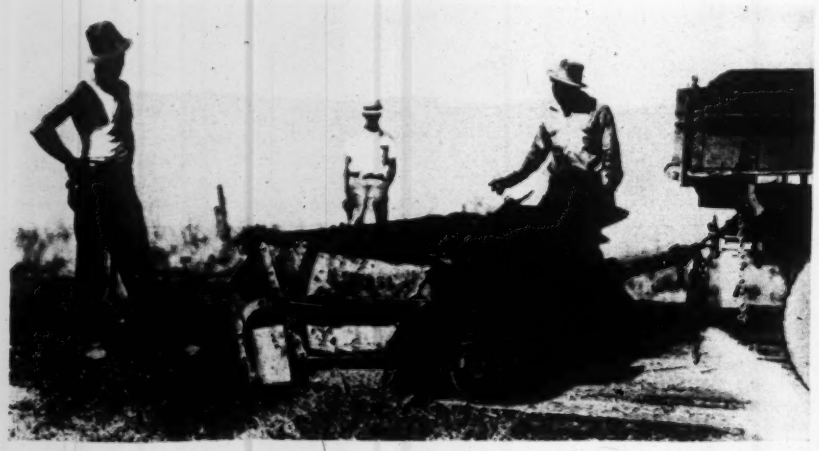
Blade grader finishing off material from spreader boxes for final rolling.

gration asphalt mixtures, which had a tendency to pick up on the blade.

Spreading was done exclusively by machines, and the use of hand rakes was not permitted. After the material had been struck off with the blade grader it was rolled with a 10-ton tandem road roller and covered with about 5 lb. of sharp sand per square yard. Work was done on one-half width of the highway at a time, permitting one-way traffic. The surfacing was struck off at depths varying from 1 to 5 in. Surfacing more than 3 in. in depth was spread in two courses.

This experiment proved very successful and demonstrated that a high-class plant-mix surfacing could be manufactured and placed at a reasonable expense using road equipment methods with a result that proved surprisingly smooth and uniform. It was carried out under the direct supervision of the author, assisted by H. G. Smith, division engineer, under the general direction of R. A. Klein, state highway engineer.

Distributing plant-mixed, low-penetration bituminous surfacing with spreader boxes.



# National Bureau to Register Engineers Is Organized

**Registration in a national bureau is expected to aid in developing reciprocity among state licensing boards—Plan is one step in larger program for raising professional standards**

ORGANIZATION of a National Bureau of Engineering Registration has been undertaken under the auspices of the National Council of State Boards of Engineering Examiners. The formation of such a bureau has been under discussion for some time, and last October, at the annual meeting of the National Council, a committee was appointed to work out the details of the organization and administration and, if it seemed desirable, to set up the bureau. The committee, consisting of Hugh A. Kelly, L. M. Martin, H. D. Mendenhall, D. B. Steinman and T. Keith Legaré, has completed its report and has set up the nucleus of the bureau. Headquarters of the bureau have been established temporarily at Columbia, S. C., in the office of the secretary of the National Council of Engineering Examiners, and T. Keith Legaré, secretary of the National Council, has been named secretary of the new bureau.

In its report to the National Council the committee recommends that the proposed national registration of engineers be considered as but one step in the advancement of a far larger and more comprehensive program by which there may be established a unified plan enabling young men entering the profession to proceed along definitely prescribed lines of technical education and professional experience, through successive stages to recognized standing in the profession. Such a program of certification into the profession already has been proposed by the American Society of Mechanical Engineers and now is under discussion by representatives of the national engineering societies, the National Council of Engineering Examiners and the Society for the Promotion of Engineering Education. Registration by state or national boards of engineering examiners would be one step rather than the ultimate aim of such a program. As the committee believes that establishment of the national bureau of registration may be expected to aid materially in advancing the broader program as well as in unifying state requirements for licenses or registration it has undertaken its organization now. Ultimately, the committee looks forward to the national bureau's absorption into the larger scheme when it shall have been consummated.

The purpose and the methods of operating and financing the new bureau are outlined in the organization committee's report to the National Council of Engineering Examiners. The following paragraphs are quoted from that report:

"*Purpose*—The purpose of the National Bureau of Engineering Registration shall be to investigate and verify the records of applicants and issue to those who fully comply with the regulations and requirements adopted by the bureau a "certificate of qualification," which may be used as evidence of qualification—for registration as a professional engineer in those states agreeing to recognize said certificates, for membership in national and state engineering societies, in connection with award of professional degrees by engineering colleges, for presentation to clients when soliciting contracts for professional services, and for presentation to prospective employers when applying for positions.

"*Administration*—As provided for in the resolution of the National Council of State Boards of Engineering Examiners, the National Bureau of Engineering Registration will be administered by a committee of three, appointed annually by the president of the National Council, due consideration being given to the desirability of continuity of terms, and this committee will be assisted by an advisory board of representatives of national engineering societies. The committee shall formulate and adopt regulations for the administration of the bureau, including standard requirements for registration, information required of applicants, examinations, issuance of certificates, copies of records, collection of fees, etc. Applicants shall be required to furnish information relative to, and certificates will show rating on, education, professional experience, membership in national engineering society, registration with state board and technical examination. When examination is required, it shall be in accordance with regulations approved by the bureau, shall be conducted by examiners appointed by the bureau and held at such place as may be designated in the state of which the applicant is a resident. Applications shall be rated and approved by the executive secretary except in complicated cases, which will be submitted to the committee. The secretary of the National Council shall be the executive secretary of the bureau and will be in active charge of the work of the bureau, serving under the direction of and at the pleasure of the committee, at a salary fixed by the committee. An annual report of the activities of the bureau shall be submitted to the National Council.

"*Finance*—Funds for maintaining the bureau shall be derived from fees received from applicants, the charges for the services of the National Bureau to be as follows:

| | |
|---|---|
| Investigating record and issuing certificate of qualification | $10 |
| When examination is required, an additional fee of | 10 |
| Certified copy of application and certificate | 5 |
| Sets of examinations prepared for state boards | 25 |

"The funds of the bureau shall be kept in a national bank in the name of the National Bureau of Engineering Registration. The executive secretary shall be under a surety bond, the amount to be fixed by the committee and the premium to be paid from funds of the bureau. An audit of the accounts of the bureau is to be made annually by a certified public accountant.

"*Location*—In order to operate the bureau at a minimum cost the offices of the National Bureau of Engineering Registration shall be located in Columbia, S. C., in connection with the present offices of the secretary of the National Council of State Boards of Engineering Examiners. The committee is of the opinion that when the activities of the bureau develop sufficiently it may be advisable to establish headquarters in Washington, D. C."

## New Wood Preservative on the Burlington Railroad

Tests with the zinc-meta-arsenite wood preservative on the Chicago, Burlington & Quincy Railroad are reported to indicate that in piles (standing in water) and in track ties the toxic salts are not washed out or leached out, as the presevative is not soluble in water. Thus piles in the Mississippi River examined in 1931, after two years of service, showed no signs of decay. Penetration averages a depth of 3.3 in. in the piles. Test sections of track with track-circuits for signal operation and having 10,000 ties treated in the same way showed less leakage of current than track having ties treated with the zinc-creosote process. Spikes that had been in the ties for three years showed no excess corrosion due to the presence of this preservative.

While the use of this method of treatment for piles and ties is experimental, it has been provisionally adopted by the Burlington for poles and for planks used in paving bridges and grade crossings. The preservative is applied to the extent of about ½ lb. per cublic foot in piles and ⅛ to ¼ lb. in ties, with an average penetration of 100 per cent of the sapwood and a portion of the heartwood. The treatment is applied at the railway company's plant at Galesburg, Ill., and a commercial plant at Denver, Colo.

# Demoralization and Reorganization in the Cement Industry

**Present conditions, their causes and effects, with some suggestions for a practical realignment of production facilities to insure more efficient and economical distribution and better protection for the consuming public and the investor**

By O. Fred Rost
*Marketing Editor, The Business Week*

*—In two articles*

## *I—Competition and Price Collapse*

WHEN the present series of articles on the distribution of various construction materials was planned, conditions in the cement industry were just approaching a crisis. The burden of an extraordinary excess of production capacity was beginning to have its effect upon the distribution practices of the industry, and it was difficult to foretell just when and where a point of stabilization might be reached.

This very necessary event has not yet occurred and, instead of improving, the competitive conditions in the industry have grown from bad to worse. The manufacturers, with more capacity to produce than the country can be expected to absorb for many years to come, have decided to get business at any cost. In the scramble, ethics have been thrown into the discard, so that today this industry, which up to 1924 was developing with some reasonable degree of stability, finds itself in a condition bordering on chaos.

The selling of cement has in many instances developed into a process of auctioning, with each succeeding bid lower than that previously quoted; and, as may be readily expected, the final successful bidder generally has gained not merely an order for tonnage but also the privilege of a more imposing collection of red-ink figures in his operating statement.

Earnings of cement companies have declined with unprecedented rapidity. They were cut in half between the years 1928 and 1930, and if the 1931 statements already published are any criterion, the majority of the cement companies will register losses ranging from merely a reduction of the previous surplus to actual loss figures that in a less amply financed industry would spell insolvency.

The manufacture of cement is one of the country's great industries. It represents an investment of nearly three-quarters of a billion dollars, and normally provides a livelihood for about 40,000 wage earners, while the common and preferred shares, bonds and debentures of the various cement companies represent to many investors a substantial part of their fortune.

It follows that if the current trend in the industry is permitted to prevail, if profitless operation or staggering operating losses are to continue unabated, many concerns now engaged in the manufacture of cement will inevitably fail, thousands of investors will suffer severe losses, and the public and the country at large will gain nothing in return.

Because of these various important factors it was felt that during this critical period, when a great industry with its entire distribution system is undergoing such momentous changes, the original plan to present merely an article on the distribution of cement should be modified. It appeared that instead a genuine service might be rendered to the public at large, as well as to the industry, if some plans and procedures were suggested that could reasonably be expected to serve as the foundation for a process of realignment of the producing capacity in the cement industry, to the end that a better balance between production and distribution might be effected and that economic losses otherwise inevitable may be averted.

The present article sketches briefly the history of the cement industry and brings into focus the various factors that have combined to produce the prevailing state of semi-disorganization and chaos. The several plans of suggested realignment will be presented in a second article.

* * *

The cement industry of today had its beginning in the year 1824, when Joseph Aspdin, a bricklayer of Leeds, England, burned certain quantities of lime and clay in a kiln, then pulverized the substance that resulted and used it to make concrete. According to the Portland Cement Association, he obtained a patent on the process and, thinking that the product resembled a stone quarried on the Isle of Portland, he called it portland cement.

The use of portland cement in the United States grew rather slowly up to 1890, so that in that year there were only sixteen plants manufacturing portland cement in this country. Their output totaled about 335,000 bbl.

Improvement in the art of using cement gradually broadened the market for the product in ordinary building and construction work. However, the use of the material received its most important impetus when the use of cement for road foundations and road surfacing was found practical and economical. With the steadily increasing popularity of the motor car and the accompanying demand for better roads, the market for portland cement expanded rapidly. But unfortunately this rapid growth in demand brought about a still more rapid expansion of production capacity.

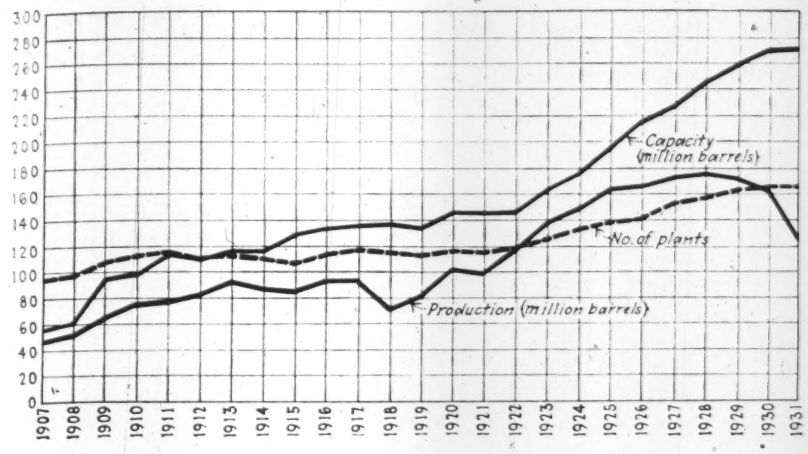
The accompanying chart, prepared from figures of the U. S. Department of Commerce, Bureau of Mines, effectively illustrates the rate of expansion in cement consumption as well as the increase in capacity of the industry to produce.

It will be noted that consumption reflected in actual production figures grew with but slight fluctuations during the years 1907 to 1917 and then dropped sharply as the result of our participation in the World War. But only two years later, with the beginning of 1919, cement production started a spectacular climb that, after hesitating slightly during the first post-war deflation year 1921, continued practically unabated until the peak year 1928, which saw 176 million barrels of cement produced in this country. The growth in producing capacity reflects substantially similar movement, but the chart clearly shows that the industry made no attempt whatsoever to synchronize increases in capacity with actual or potential growth in consumption.

### Widening spread of supply and demand

In 1907 there was a difference of only 7 million barrels between capacity and consumed production, which meant that the industry was burdened with only 11.3 per cent of excess capacity. The first wave of expansion, ending with the year that marks the beginning of the World War, 1914, carried capacity from 55 million in 1907 to 115 million barrels in 1914. This figure was not approached in actual production until eight years later. But in those eight years the industry had built up to a capacity of 140 million barrels annually and therefore was carrying at the end of 1922 the burden of 21.5 per cent of extra capacity, or almost double the amount it had in 1914.

Despite the fact that these figures on capacity and actual production were at




The spread between plant capacity and production, steadily increasing since 1907, has brought the industry into 1932 with a burden of 54 per cent excess production capacity to contend with.

the disposal of all interested persons, and unquestionably were known to those who guided the affairs of already-existing cement manufacture as well as to promoters and prospective newcomers in the field, their significance appears to have gone unheeded.

A period of unprecedented expansion followed. The seven years from 1922 to 1929 saw 45 new plants built and the production equipment of the industry increased at a staggering rate, to a total capacity estimated by the U. S. Department of Commerce at 258 million barrels at the end of 1929.

It was during 1929 that, for the first time since 1921, cement production fell below the total for the previous year and thus began to widen in both directions the rapidly growing gap between capacity and salable production. Nevertheless, the orgy of plant expansion had not yet run its course, and a study made in June, 1930, showed that, in addition to plants then in production or able to produce, three more plants were under construction, nine more plants had been planned and financed, and thirteen were being planned and financed.

As a result of these operations, the end of 1930 saw the capacity of the industry pushed to the unprecedented total of 270 million barrels, while actual production during the same year declined further and dropped to 161,197,228 barrels, which meant that there then was 40.3 per cent of excess capacity.

## Excess capacity now estimated at 54 per cent

While final figures on production during 1931 are not available at this writing, it is generally conceded that the preliminary figure of 124,594,000 bbl. is not far from being correct, which justifies the statement here that on the basis of 1931 production the cement industry had 54 per cent excess, or more than twice as much capacity as was needed. This fact gains in significance when a reference to the chart will disclose that even sixteen years ago the industry appears to have had sufficient capacity to supply the 1931 requirements.

Of course the cement industry, along with all others, must always have some surplus capacity to provide for inevitable peaks in demand or to permit replacements or betterments of equipment without impairing its ability to serve. Furthermore, the increasing importance of the cost of transportation as a deciding factor in the possible on-the-job cost of cement has to a degree justified the erection of some plants in rapidly growing territories by companies that already were maintaining sales organizations in those territories and that thereby were enabled to effect delivery more economically. Nevertheless, the figures clearly indicate that the rapid expansion in production capacity proceeded by and large in the direction dictated by competitive considerations rather than on the basis of sound economic planning and actual needs.

## Tonnage competition causes price decline

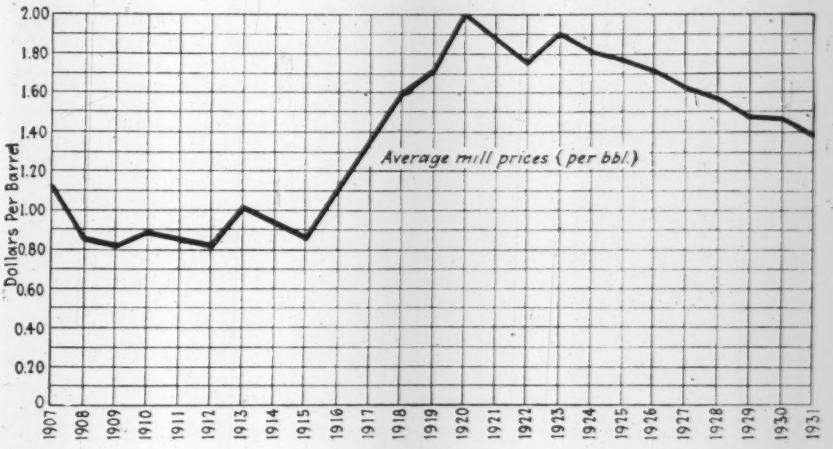
That this conclusion is not merely justified but practically unassailable is demonstrated by the movement of cement prices as shown on the accompanying chart. All opinion to the contrary notwithstanding, the prices of cement, like those of any other commodity, respond unerringly to the laws of supply and demand.

Average prices of cement at the factory rose from $0.85 per barrel in 1908 to $2.02 in 1920. This rise in prices took place while the industry accomplished its first major wave of prosperity and expansion in production capacity.

The first post-war depression affected all three factors—production, consumption and price—simultaneously and caused generally unsettled conditions for several years. During 1921 total production receded slightly from its 1920 record high, new plant construction lagged during 1921 and 1922, and prices began a decline that lasted into 1923, during which year, however, a price increase averaging 14c. per barrel is recorded.

It is important to register the position of the three curves at the end of 1923 and observe their course during 1924. It will be noted that during the year when the industry achieved its nearest approach to balance between capacity and production since 1908, and was operating at 85.3 per cent of capacity, the prices began to decline. This decline was undoubtedly inspired to a considerable degree by the increased burden of financing plants in construction and the resulting hunger for tonnage. As the succeeding years widened the gap between capacity and production and increased the difference between supply and demand, the price curve declined in obedience to the well-known law.

From the recent record peak of $2.02 per barrel in 1920, cement prices dropped until in 1930 the average, according to government figures, stood at $1.44. Although the 1930 performance




Since 1923 the price curve has dropped consistently. Comparison with the graph above shows that the rate of price decline closely approximated the rate of expansion of plant capacity during the same decade.

records of various cement companies demonstrated the effect of carrying such excessive capacity in a market that was declining in both volume and value, no effort was made toward effecting a feasible and sensible adjustment.

### Vicious dealer differential firmly intrenched

While one attempt was made by a large cement-manufacturing company to strike at the most vicious practice in cement selling, it was unfortunately unsuccessful. That company announced late in 1930 that the traditional 10c. per barrel differential payment to dealers of all classes would be discontinued and that instead duly established dealers would receive at the end of each calendar year a payment of 5c. per barrel on all shipments where the usual service functions had been actually performed.

Unfortunately, the established dealers in cement or other building supplies failed to appreciate the fact that the new plan would give them protection not previously enjoyed against their most destructive competitor, the piratical, mythical, itinerant "dealer." The latter type of dealer could generally be found in practically all territories, and he performed no particular function but frequently was a henchman of the politicians who had control of the letting of contracts. As political go-betweens or dummies they became dealers and collected the 10c. per barrel differential from the cement manufacturer and then distributed it to the most worthy or efficient "workers."

Just what this seemingly insignificant differential of 10c. per barrel could involve in the way of contribution can be more thoroughly appreciated if a specific case is cited. A county decided to build 15 miles of concrete road 18 ft. wide and 8 in. thick. Under accepted engineering standards such road, including possible gutters and culverts, would require an average of 4,000 bbl. of cement per mile, or a total of 60,000 bbl. for the job. Thus the 10c. per barrel differential on this comparatively small job represented the respectable sum of $6,000.

Just how much that seemingly insignificant differential may have meant to the political "industry" of the nation, and its interest in various roadbuilding contracts can be estimated when it is realized that during 1931, the depression year, contract awards actually made for concrete highways represented the formidable total of 134,916,852 sq.yd.

While the federal government and also many state and municipal authorities have gradually insisted on buying cement for public construction direct from the manufacturer, this fact had by no means eliminated the existence of a differential.

When the company above mentioned made its attempt at abandoning the differential in its old form, a number of important cement companies welcomed the leadership and followed with announcements of a similar change in selling policy. However, there were a number of others who did not care to follow the plan for various reasons, while some chronic disturbers saw in this move a golden opportunity to corral some extra business, particularly from supply dealers who had been unable to realize that the new plan gave them exceptional protection.

The inroads made by some of the "hold-out" cement manufacturers in the business of constructively operated companies and their invasion of territory where they actually could not compete economically eventually forced the abandonment of the plan. Some manufacturers have gone back to a differential arrangement, some pay a differential upon a cash-discount basis, and others abandoned the differential entirely. The period of price competition that ensued has brought utter disregard for overhead and production costs, almost complete abandonment of business ethics and carried prices in some territories to the lowest level in history.

### Standard specification contributes to price demoralization

Despite the fact that whenever the price at the factory goes below $1.50 per barrel, the possibility for paying even the production cost appears to be practically eliminated, particularly for the older and less efficient plants, the industry as a whole has throughout this price war followed its long-established price practice. This practice is identical with that followed by custom on practically all commodity exchanges where commodities are traded in which conform to certain standard specifications and the trade simply accepts the last quoted price in any given marketing area as the current market price. This is how that plan operates:

When a specific contract for cement is awarded to the lowest bidder at a price that differs from that previously quoted in the same freight or distributing area, that most recent quotation automatically becomes the current market price and is quoted to all current or prospective buyers in that area until superseded. It is a well-known fact that on regular exchanges the current price of a common stock or bond, of cotton, coffee, potatoes or wheat is that at which the last sale was actually made, and that price remains the market price until replaced by a succeeding actual transaction. Buyer and seller accept the established standards of practice, and the buyer, knowing that grading is standardized, has generally only a secondary interest in the origin or specific source of the commodity purchased.

Obviously, this simple procedure of dealing in a standardized commodity has its advantages as well as disadvantages for both buyer and seller. When specifications for portland cement were finally standardized, it was thought that the results of such standardization would be overwhelmingly advantage

Until 1909 large users had formul their own cement specifications, which manufacturers were obliged conform. This naturally resulted much confusion and frequent disp as well as higher production c During 1909 the standard ce specifications of the American Soc for Testing Materials were gene adopted, and thereafter all so-ca portland cement was presumed to c form to those specifications. W some engineers have preserved a defi preference for one particular brand cement, the popular conception has b that "all cement is alike." Thus, w some of the most vexing producti problems eliminated, the cement ind try had a genuine opportunity to ca talize the standardization of its prod and undertake to develop an economi system of distribution.

### Recent selling practices certain to break prices

Unfortunately, this was not done, a in the period of intense competition th has prevailed since consumption o cement began to decline from the 192 peak the rapidly increasing scarcity o orders prompted some manufacturers t use the fact of standardization as th basis for destructive practices. Som cement manufacturers made raiding ex peditions into new territories, general in pursuit of a specific large order They would quote prices far belo "market" in such territory for the sak of obtaining a substantial backlog o tonnage ordered, and then attempt t sell as much tonnage as possible in thei normal territory at prevailing general higher prices in the hope of thereb making a profit on the year's operation or at least of breaking even. Other con cerns sniped at the dealer organization of their competitors, using various promises and concessions as ammuni tion, and succeeded in some instance in severing dealer-manufacturer rela tions that had existed almost since the beginning of the industry. Still other cement makers capitalized the established rulings of the Interstate Commerce Commission, which gave them the advantage of lower freight rates to certain specific shipping points over other manufacturers who were actually equally well qualified to serve the particular re quirements and perhaps from every standpoint excepting freight rates more advantageously located.

All these expedients of unbridled competition for available tonnage have naturally left their permanent imprint in the recorded quotations of market prices of cement. Manufacturers found that they could not "sell short" in a neighboring territory and expect to have the "long" price prevail in their natural marketing area. Executives who were interested in maintaining their own competitive position within their logical territory found it necessary to

extend their operations beyond its boundaries over a larger area. Quotations made on specific requirements of large users were analyzed to determine the actual at-the-mill price, by deducting from the quoted price the freight charges, etc., involved. The practice of accepting "basing point" prices as market prices for a given area came into vogue.

When a Midwest state called for bids on its 1932 requirements and awarded the contract for 2½ million barrels to a manufacturer at a price that figured 64c. per barrel at-the-mill on "basing point," competitors in that territory saw themselves forced to bring their own prices on this standardized product down to that basis. When another Midwest state called for 1932 bids, it obtained the lowest figure from a maker who proposed to furnish only a part of its requirements, and state officials were forced to "sell" other higher bidders the idea of supplying the remaining parts of the state's requirements of this standardized product at the same low market price that their competitor had established.

Thus the standardization of cement, which when first achieved had been hailed as a stabilizing influence and proclaimed as being of material advantage to buyer and seller alike, has in this period of frantic struggling for tonnage and price made much trouble.

### Special cements added fuel to price war

In recent years some manufacturers have attempted to gain preference over their competitors by offering special types of cement, for which special advantages such as quick setting and high early strength were claimed. While under normal conditions and within an industry with no extreme problem of overcapacity, these attempts to abandon standardization in favor of open competition on quality might have been successful, they only served to aggravate the already serious conditions in the cement industry and further contributed to the viciousness of the price war.

It will be noted that all these major externally perceptible manifestations of evils resulting from the industry's running amuck and building not-needed plants, eventually find expression in the selling price of its product. That is the reason why the history of the decline of cement prices, which carried average prices from the 1920 peak of $2.02 per barrel at-the-mill to the already cited instance of a 64c. quotation for some 1932 requirement, is so closely interwoven with the tremendous expansion that it accompanied.

Internal evils grew with equal rapidity but did not become visible until the Wall Street crash of 1929 closed the seemingly ever-flowing spring of easily obtainable capital and ready profits on which executives and promoters had relied. Since 1929 these evils have burned through to the surface, and their effect has become visible and measurable through proper analysis of the earning statements of cement manufacturers.

### Unused plant capacity raises unit-production cost

The cost of manufacturing cement varies with the efficiency of the producing machinery and the management that operates the plant. Beyond the actual cost of the physical production, plant, overhead, depreciation, interest charges, executive and sales overhead as well as other costs must be added before the final cost at-the-mill can be properly determined. Under extreme conditions of efficiency and while maintaining production at 100 per cent of capacity, it has been considered possible to deliver cement at the end of the production process for 65c. per barrel in bulk net cost. If the ratio of output is decreased and if producing plants are less highly efficient or under less able management, the cost rises rapidly.

Since the excess of producing capacity made itself felt, very few plants have been able to operate at 100 per cent capacity; while thus the relative cost of production was forced to rise, competitive conditions forced selling prices constantly farther downward. It has been estimated that, if all direct and indirect charges are fairly applied, there has been since 1928 little cement produced that did not cost the manufacturer $1.50 per barrel to get to the shipping bin. Yet the average selling prices have been declining steadily.

The performance of some important cement manufacturers as reflected in their operating statements for 1931 indicates that the estimate made in the previous paragraph may prove to be quite accurate. One large company finished the year with a loss that averages nearly 10c. per barrel on its estimated shipments. Another shows a closing statement that indicates a loss of nearly 15c. per barrel. Other cement companies that have issued their annual statements show with few exceptions operating losses. If normal charges for obsolescence and depreciation were included in all instances, the losses might run far higher.

These losses were sustained in a year when, according to government reports, prices at-the-mill averaged $1.393 per barrel, and while the industry operated at approximately 46 per cent of capacity.

The first important 1932 cement contract is reported to have been taken at the equivalent of 64c. per barrel at-the-mill, or at less than 50 per cent of the 1931 average price, while reliable forecasts of consumption for 1932 place the required tonnage at 100 to 110 million tons, or less than 40 per cent of capacity. Thus the selling price of cement is apparently going to continue its decline, while the constantly shrinking ratio of production will further increase the actual cost of manufacture.

Obviously, the cement industry must create a new *plan of operation* that will make possible greater balance between production and potential distribution if serious disaster and tremendous economic losses are to be averted. Until cement can be made and sold so that neither the seller nor the buyer will sustain direct or indirect losses, no one unit in the industry can long prosper.

# Schedule of Charges for Sewage Works on a Rational Basis

MUNICIPAL engineers are frequently confronted with the problem of setting a rate schedule to acquire a fund to pay for a sewage system supported as a utility. In a committee report by S. A. Greeley and Frank A. Marston to the American Society of Municipal Engineers at the Pittsburgh convention, figures for a city of 10,000 people and 2,000 connections were assumed. Of the $500,000 total cost $250,000 was allocated to collecting sewers, $125,000 to interceptors and $125,000 to treatment works. Of the $50,000 assumed as the total annual cost $35,000 was for bond interest and retirement and $15,000 for maintenance and operation. The committee found as follows:

Since the entire community benefits and land values are enhanced by the readiness to serve, taxes should carry a portion and the users a portion of the cost. As a rational way of getting at the division the relative costs of the long- and short-lived structures were investigated. That portion of the plant costing $410,000 was given a life of 40 years without enlargement, and $75,000 was assumed to require enlargement at the end of fifteen years. The remaining $15,000 was to last fifteen years only.

In making up the rate basis the users were charged with all of the $15,000, 25/40 of the cost to go for structures needing enlargements at the end of fifteen years and 15/40 for long-lived structures. Their total interest in the capital cost will then be about 40 per cent. This gives $15,000 for the rate schedule to provide if operation only is to be covered, and $29,000 if operation plus 40 per cent of capital costs is covered. If rates are gaged by charges on the water-consumption basis, the above means 7c. must be collected per 1,000 gal. when operation alone is paid for by users, and 15c. per 1,000 gal. when operation and 40 per cent of capital cost is the basis of the charge for use.

# Engineering Literature

## A Monthly Review of Books and a Listing of New Publications

### Great Service Rendered

REVIEWED BY CHARLES J. TILDEN
*Professor of Engineering Mechanics, Yale University, New Haven, Conn.*

ADVANCED MECHANICS OF MATERIALS—By Fred B. Seely, M.S., Professor of Theoretical and Applied Mechanics, University of Illinois. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. 331; line cuts. $5.

DESIGNING engineers are recognizing more and more the importance of supplementing generally accepted procedure in structural design with a consideration of the results of tests and researches in the field of strength of materials. A number of technical schools are offering courses for graduate students along these lines. Prof. Seely in his "Advanced Mechanics of Materials" has done a great service not only to the engineering profession but to those who are engaged in teaching, in bringing together in a concise and readable volume the major results of these investigations and adapting them, in itself no small task, to teaching and study.

The book is divided into four parts, beginning with an excellent and rather philosophical discussion of preliminary considerations, the assumptions and limitations involved in the elementary formulas and an unusually clear presentation of the theory of internal stress.

In Part II special topics are considered, including thick-walled cylinders (Lamé's solution, etc.), the limitations of the flexure formula for sections having only one axis of symmetry, unsymmetrical bending, curved flexural members (closed ring, chain link and crane hook), flat plates and the torsional resistance of bars of non-circular cross-section. The chapter on unsymmetrical bending should be of value to every structural engineer. Particular attention might be called to the table on p. 100, showing the percentage of increase in fiber unit-stress and the change in slope of the neutral axis caused by a 1-deg. inclination of the plane of the loads with a principal plane of the cross-section of the beam. A slope of 1 deg. means a "bevel" of less than ¼ in. per foot. In a large I-beam (18-in., 55 lb. and above) the fiber stress is increased more than 20 per cent if the plane of the loads departs only 1 deg. from the principal plane of the section and the slope of the neutral axis is changed by more than 30 deg. This departure of 1 deg. will occur if the web of an 18-in. I-beam, under vertical loads, is ⅛ in. out of plumb. The chapter on torsional resistance starts with an admirable discussion of Bach's classic work on torsional stress variation in bars having elliptical and rectangular sections, and follows this with an interesting discussion of the elastic-membrane, or soap-film, analogy.

Part III takes up localized stresses, with the resulting stress concentration, and describes the various methods of analysis: plastic-material, rubber-model, polarized-light, and so forth. Part IV is an introduction to the analysis of stresses in statically indeterminate members, particularly by use of the elastic strain energy method.

There is an appendix on properties of an area, including first moments and centroids, the second moment or moment of inertia, and product of inertia. There is also an author index and a subject index. At the end of each chapter is an excellent list of references.

As an example of engineering design the book is a model. The plan is clear and well thought out, the text unusually simple and well written, the draftsmanship of the many diagrams excellent. The book was written primarily as a text for graduate students, and it serves this purpose admirably. Moreover, the literary quality is so high and the whole book so well documented that the practicing engineer who wishes to extend his reading in the field of mechanics of materials will find it a valuable addition to his working library.

### Needs More Revision

RAILROAD CONSTRUCTION Theory and Practice: A Text-Book for the Use of Students in Colleges and Technical Schools, and a Hand-Book for the Use of Engineers in Field and Office—By Walter Loring Webb, C.E., Mem.Am.Soc.C.E., Mem.Am.Ry.Eng.Assoc., Mem.Am. Concrete Inst.; Assistant Professor of Civil Engineering (Railroad Engineering) in the University of Pennsylvania 1893-1901; Major, Engineer Corps, U.S.A., 1917-1920. Ninth Edition. Thoroughly Revised and Reset. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Flexible; 5x7 in.; pp. 699; line cuts and tables. $6.

THE ninth edition of Webb's well-known standard work on the theory and practice is disappointing. Though it has, according to the publisher's statement, been "thoroughly revised and reset," it is far from being up to date on those features of railway construction which change constantly—the structures, equipment and costs. A whole page is devoted to tile pipe culverts, including a drawing of a "standard" vitrified-pipe culvert of the year 1891, yet only four lines are devoted to concrete pipe, which has so largely superseded tile pipe. Corrugated-iron culverts are not mentioned. Arch culverts shown are of brick and stone masonry, Norfolk & Western standards of 1891, plate girders those of the C. M. & St. P. Ry. of 1895, and most of the track fastenings shown are found now only in railway museums. The section on the preservative treatment of ties is taken verbatim from the edition of 1926 despite the great progress made in timber treatment in recent years. The same might be said of many other items, especially of the illustrations of such things as locomotive boilers, freight car trucks and terminal layouts.

For the railroad man who turns to the book for its valuable tables and concise presentation of some of the unchanged fundamentals of railroading this is not a great drawback, but to the student who uses the book for study or research as to what is accepted modern railroad practice this presentation of antiquated matter in an edition dated 1932 will be highly misleading.

### Great Work Completed

THE BUILDING OF THE CITY: Regional Plan, Vol. II—By Thomas Adams, Assisted by Harold M. Lewis and Lawrence M. Orton. New York City: Regional Plan of New York and Its Environs. Cloth; 9x12 in.; pp. 600; maps, diagrams and halftones. $25 for this and the other "plan volume," $3 each for eight "survey volumes"; $50 for the entire ten volumes and a copy of the "graphic plan" for mounting.

NINE years of study and planning is ably summed up and elucidated in the second and final volume of "The Regional Plan of New York and Its Environs." This volume is aptly titled "The Building of the City." Fittingly it is written by the master planner for the work, Thomas Adams. It is a pleasure to note that of his two assistants in the task Harold M. Lewis is the son of the late Nelson P. Lewis, who for some years preceding his death was chief of the engineering staff of the regional plan, and who before that had done much notable planning work during his long career as chief engineer of the New York board of estimate and apportionment.

"The Building of the City" reviews the main features of the regional plan in a thoroughly readable manner. To give a good background for the forward-looking regional plan here presented a hundred pages are devoted to such historic and fundamental subjects as "city building in a democracy," "civic art in relation to street planning and architecture," "work and living conditions," and "individuality of communities and their common problems." This and the later discussions are constantly enriched by examples of city planning at home and abroad. These include a review of the original plan of our national capital by L'Enfant, guided by Washington and Jefferson and assisted

and carried on by Ellicott, and also of the replanning of Paris.

There are chapters on planning land and buildings, zoning, housing and transportation terminals. From these general considerations applicable to the whole region Mr. Adams turns to the problems of upper and lower Manhattan, the Bronx and other parts of New York and environs.

The numerous well-chosen and handsomely reproduced illustrations, some of which are after colored drawings, enhance the beauty and usefulness of the volume. Scores of pertinent views gleaned outside of New York City—from both Americas, Europe and more distant continents—together with comment on them, add to the breadth of treatment in this monumental final volume of the Regional Plan of New York and Its Environs.

## Building an Empire

GRINGO BUILDERS—By J. L. Allhands, Joplin, Missouri, and Dallas, Texas. Privately printed. Cloth; 6x9 in.; pp. 283; photographs. $3 from Clio Press, Iowa City, Iowa.

IN INIMITABLE style and language, peculiar to his kind, a contractor has presented a most unusual tale of the development of that vast territory comprising the lower Rio Grande Valley in Texas, an empire in itself. We are prone to consider the development of virgin territories in the United States as belonging to the last century, but here is a thrilling story of the opening up of a new country in which the action takes place in the first fifteen years of the present century.

It is primarily a story of the building of the St. Louis, Brownsville & Mexico R.R. (now a part of the Gulf Coast Lines) between Algoa, just outside of Houston, south to Brownsville, skirting the Gulf of Mexico. However, the author wanders far afield from actual railroad construction at times and gives us interesting historical sketches of towns the railroad finally reached but which were founded years before the coming of the rails. Development of irrigation projects, which accompanied the settlement of the country, is described. Corpus Christi, Brownsville, Bloomington and Brazoria are some of the places so treated. Also the book is rich in biographies of those who have made Texas a great state. Just tribute is paid to such characters as the Johnson brothers, well-known contractors; Col. F. G. Jonah, now chief engineer of the Frisco lines; Stephen A. Austin, Col. Uriah Lott, B. F. Yoakum, Sam Robertson and others closely associated with the history of Texas.

The St. Louis, Brownsville & Mexico R.R. was built in three sections, one from Robstown south to Brownsville, another north from Robstown to Bay City and the third connecting Bay City and Algoa. All the situations encountered in pioneer railroad building are vividly described, including heartbreaking struggles to bridge uncrossed rivers on flood rampages of which only streams of the Southwest are capable. The country itself is accurately described, with due attention to the picturesque old ranches covering areas larger than many of our smaller states. Even the wild, scrawny longhorn steer, a typical Texas product now but a memory in these days of more scientific stock breeding, is given a chapter in the story.

The author has the power to take the reader right into the construction camps and out on the grade. His language makes one at all familiar with construction feel right at home. The old construction camp scene is thus described:

> There was the magic story teller; and on those dark, melancholy days of rain the champion poker player came into his own. It meant sitting in that game of continuous gambling, in their none too comfortable quarters, filled with smoke and the many odors that cling to working clothes, until his winnings had cleaned all of his poker-inclined buddies, while others, in placid contentment, puffed away on their pipes, some of which would gag a buzzard, and looked on. They bathed only in the facilities nature provided, if any.

Yellow fever, that scourge of the lowlands, threatened once to stop all operations, but "after a rigid shotgun quarantine the fever was finally stamped out." Those familiar with construction lingo will know that the author is describing a main street when he says "one-half of Chaparral St., the main drag of the city, was under water during rainy spells."

In addition to giving the history of the older towns, each new village springing up alongside the ever-progressing rails is described, usually with a bit of interesting news concerning the selection of a name.

The author was intimately connected with construction operations. He acknowledges the debt the old grading contractors owe to the pioneer Western Wheeled Scraper Co. for the equipment made available. And last of all he pays a heartfelt tribute to the brave women who followed their men folks into that new country back in the Indian-fighting days of the early ranch settlers and later in the days of railroad building.

All in all, it is a real story of engineering, construction and pioneering.

## Overlooked Control Elements

PRICING FOR PROFIT: The Golden Rule of Business—By W. L. Churchill, M.Am. Soc.M.E., Consulting Industrial Economist-Engineer. New York: The Macmillan Co. Cloth; 6x9 in.; pp. 271. $3.

ALTHOUGH a comprehensive discussion of the large and diverse title-subject, "Pricing for Profits," Mr. Churchill's book is addressed particularly to "elements that control profit making that have been generally overlooked or unidentified as profit-controlling factors." The author states that for fifteen years he gave consulting and management service with profit betterment in mind and that his book summarizes his findings during the last ten years in "a search for the correctible causes of the inadequate earnings of so many of our excellently managed business enterprises."

The comprehensive character of the discussion is partly indicated by the following listing of some of the thirteen main divisions of the book, under each of which there are a number of chapters: "profit requirements," "the law of quantity," "pricing for profit," "goodwill," "wages, salaries and profits," "synchronizing sales and production," "advertising," "reducing costs."

The real meaning of "pricing for profit" is thus summarized by the author in the last words of his book:

> Profit is an obligation that we owe society, as all progress is derived from profit. It is therefore the obligation of all of us to conduct all of our price calculations upon a basis that will be profitable to all concerned. Not from sentiment but because of our obligations to past and future generations and so that we may make our full contribution to the progress of humanity. This is the real meaning of pricing for profit.

## Less Control Urged

REGULATION OF PUBLIC UTILITIES: A Crucial Problem in Constitutional Government—By Cassius M. Clay. New York: Henry Holt and Co. Cloth; 6x8 in.; pp. 309; $3.50.

A VERY readable presentation of a complicated subject is made by Mr. Clay in his review of the background of our present system of regulating public utilities. That system, as he views it, to be properly understood must be considered in the light of developments in the application of the fundamental principles of the federal Constitution and amendments thereto since they were first written. For that reason he begins his analysis with observations on the background of the Constitution and of the 14th Amendment, the real source of much of the litigation from which present views on rate making have come.

Mr. Clay lays particular stress upon the human element involved in court decisions and upon the progressive changes which the make-up of the supreme court and changes in the opinions of its members have brought about. Thus:

> Because the Constitution mostly embodies general principles, the inquiry as to whether the act of a state legislature, or a commission lawfully constituted by it, allows a public utility a fair return upon the value of its property raises questions about which men differ, and judges, the human ministers of the law, can, and do, in complete honesty, decide according to their deep-seated convictions. Because these questions arise out of, and have their being in the bewildering maze of a complex national life, there is an inescapable human element—the point of view, the economic and political philosophy and the social outlook of the individual judge.

Mr. Clay finds the minority opinions of the supreme court of special interest as indications of the future course of utility regulation. "Perhaps," he states, "when the historic record is complete, the rule of the future may be found to have been foreshadowed in the prophetic dissents of the past."

Working from this premise, Mr. Clay finds reason to expect an improvement in what he now considers to be an

undesirable situation. In his conclusions Mr. Clay says:

> The attempt of the majority of the supreme court, by the emphasis placed upon reproduction costs, to control commission's findings of value represents an excursion by the court into controversial economics. It is further an exercise by the court of economic control under the guise of conceptual legal logic. A recession by the court from the current doctrine of present fair value will leave the duty of fixing rates that are fair from a business standpoint where under a view which has found favor with the court in other days it properly belongs—with the state commissions and other regulatory bodies.

Evidence of this recession Mr. Clay finds in decisions since two new judges took their place on the bench. The minority, who in the preceding years had raised their voice against extensions of federal authority into the province of the states, he now finds writing the majority opinions. With this change, the author finds hope of support of his essential thesis, which is "that public regulation, at least of electric utilities, should be left, so far as is compatable with national interest, to the separate states."

## Large and Unique Sewage-Works

CITY OF BRADFORD (England) Works of Sewage Disposal, with Some Historical Notes on Problems arising in connection with the Treatment of Effluents from the Textile Industries, 1870-1931—Third and Revised Edition. H. Wontner-Smith, Engineer Sewage Department, Bradford, England. Stiff Paper; 6x10 in.; pp. 91; folding maps and profile.

THE sewage of Bradford, England, is unique because of its heavy charge of wastes from textile industries, particularly dirt and fat from wool washing. These wastes finally led the city, some years ago, to adopt a plan to treat its entire sewage by a combination of chemical precipitation and trickling filters, an important element of the former process being grease recovery on a large scale. After years of construction in installments the works were completed not long ago. The sewage department has now published a handsome, interesting, informing and well-illustrated brochure outlining briefly the growth of Bradford as an industrial center, giving the history of sewage treatment there before the new works were undertaken and describing the new plant in considerable detail.

## Outside Reading

THE BOOK OF METALS—By Donald Wilhelm, Author of "Theodore Roosevelt as an Undergraduate," "Writing for Profit," "The Story of Steel," etc. New York and London: Harper & Brothers. Cloth; 6x10 in.; pp. 341; five photographic studies by Margaret Bourke-White and other illustrations. $4.

THIS book is planned to explain to a fourteen-year-old boy the origin, manufacture and use of the numerous metals that find application in our modern scheme of civilization. There is something to be said for such a plan even when the book is intended for adults, for many of us are juveniles in metallurgy and its diverse branches. So this book should be of general interest. It is not written in technical language but on the contrary goes to the other extreme of being ultra-popular in style, dramatizing too many commonplace happenings and surrounding excellent description with too much narrative. But that is a personal opinion of the reviewer. The book contains many data both useful and informing. It also is authentic, for, as the author states, each chapter has been read and approved by well-qualified metallurgists. The compass of the book is given by a list of chapter headings—iron, wrought iron, cast iron, steel, alloy steels, aluminum, copper, brass, bronze, nickel, lead, tin, gold, silver and platinum.

## Astronomy for Engineers

A TEXTBOOK OF PRACTICAL ASTRONOMY: Primarily for Engineering Students—By Jason John Nassau, Professor of Astronomy, Case School of Applied Science. New York and London: McGraw-Hill Book Co. Inc. Cloth; 6x9 in.; pp. 225; illustrations, tables and line cuts. $3.

PREPARED especially for civil engineering students in their study of astronomy as it relates to the practice of surveying, Prof. Nassau's book will be found of value also by the engineer or surveyor who must refresh his memory upon the determination of bearings and like matters. It will also be found of interest to engineers whose college training in astronomy was carried forward under the tutelage of a pure scientist who knew nothing of the type of astronomy that should be taught to engineers and cared less.

## Rail and Highway Curve Problems

ELEMENTS OF CURVE DESIGN for Road, Railway and Racing Track on Natural Transition Principles, with special notes on road planning in terms of British and Metrical Units—By F. G. Royal-Dawson, M.Inst.C.E., M.Inst.T.; Late Professor of Roads and Railways, Royal School of Engineering, Cairo; Former Chief Engineer and Director of Civil Engineering, Indian Railway Board. With a Foreword by Sir Henry P. Maybury, G.B.E., K.C.M.G., C.B., Vice-Pres. Inst.C.E.; Late Director-General of Roads; Consulting Engineer to the Ministry of Transport. London: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Cloth; 5x7 in.; pp. 230; line cuts and tables. $3.

GRAPHIC SOLUTION OF ROAD AND RAILWAY CURVE PROBLEMS with the aid of Lemniscate Transition Curves—By F. G. Royal-Dawson, M.Inst.C.E., M.Inst.T., Author of "Elements of Curve Design for Road, Railway and Racing Track." London: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Paper; 5x8 in.; pp. 12; line cuts. 50c.

RAILWAY and highway engineers concerned in curve problems, especially those of the transition curve, will find this book by Prof. F. G. Royal-Dawson on the general subject of curves and his pamphlet upon the graphic solution of curve problems of considerable interest. In addition to covering the fundamental princip underlying the simple highway or r way curve Prof. Royal-Dawson tre of transition curves, superelevati widening roads at curves, road ju tions and speedways and racetrac Much space is devoted to transiti curves, especially the lemniscate, wh is treated in detail in the separa pamphlet. Both feet and meters employed extensively in the comput tions to broaden the usefulness of t book. The section on road inters tions does not touch upon recent d velopments along that line in th country.

## Construction Operations

STANDARD CONSTRUCTION METHOD —By G. Underwood, Construction Engineer, Author of "Estimating Construction Costs." Second Edition. New Yo and London: McGraw-Hill Book C Flexible; 6x9 in.; pp. 501; photograph and line cuts. $5.

THERE are very few construction methods that can be classified a standard. Most of those that may b so classed this year will be improved upon in another season or two. There fore, Mr. Underwood is dealing wit what might be termed current construc tion practices rather than standard methods. The field of construction is so large and diversified that it is im possible to cover more than a few funda mentals of construction methods in a single volume. Within these limita tions the author has done an excellen job. He has brought up to date a work first published less than five years ago It is reasonable to assume that in an other five years additional revision will be necessary. But for the time being for those who rely upon books for their construction experience or to refresh their memory for certain procedures Mr. Underwood has provided a useful service.

## *New Books and Revised Editions*

*[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]*

AIR CONDITIONS AND THE COMFORT OF WORKERS: Industrial Health Series No. 5, Policyholders' Service Bureau, Metropolitan Life Insurance Co. Paper; 5x8 in.; pp. 20; illustrations. Free on request to the Metropolitan Life Insurance Co., New York City.

ARTIFICIAL LIGHT AND ITS APPLICATION IN THE HOME—Prepared by the Committee on Residence Lighting of Illuminating Engineering Society, Mariquita Dygert, Chairman. New York and London: McGraw-Hill Book Co. Inc. Cloth; 6x9 in.; pp. 145; illustrations $1.50.

Although written primarily as a textbook for students of home lighting, this compilation of data relating to light values, modern lighting fixtures, house wiring and lighting elements will be found of value to those interested in improving the lighting conditions under which they live and work. A dictionary of illumination terms is included, also a colored chart of the reflection factors of colored surfaces.

COUNTY GOVERNMENT: An Annotated List of References, June 1, 1915, to Dec

31, 1931—Compiled by M. Margaret Kehl. Paper; 6x9 in.; pp. 8. 5c. from Municipal Reference Library, Municipal Building, New York City.

EVAPORATION FROM FREE WATER SURFACES—By Carl Rohwer, Associate Irrigation Engineer, Bureau of Agricultural Engineering, in cooperation with the Colorado Agricultural Experiment Station. Technical Bulletin No. 271, U. S. Department of Agriculture. Paper; 6x9 in.; pp. 96; tables, photographs and line cuts. 25c. from Superintendent of Documents, Washington, D. C.

FARM GAS ENGINES AND TRACTORS—By Fred R. Jones, M.Am.Soc.A.E., Associate Professor of Agricultural Engineering, Agricultural and Mechanical College of Texas; M.Am.Soc. of Agric.E. [McGraw-Hill Publications in Agricultural Engineering, Daniels Scoates, A.E., Consulting Editor.] First Edition. New York and London: McGraw-Hill Book Co. Inc. Cloth; 6x9 in.; pp. 485; line cuts, photographs and tables. $3.75.

A textbook based on fifteen years' experience in teaching of both collegiate and non-collegiate students. The author hopes the book will be useful "to instructors in vocational work dealing with farm-type engines and tractors, to mechanics and service men, and to owners and operators of stationary engines and tractors."

GRAPHIC STATICS—By Seibert Fairman, M.S.,M.E. Assistant Professor of Applied Mechanics, Purdue University, and Chester S. Cutshall, M.S. Ch.E., Assistant Professor of Applied Mechanics, Purdue University. First Edition. New York and London: McGraw-Hill Book Co. Inc. Cloth; 6x9 in.; pp. 143; line cuts. $1.75.

Based on notes developed during fifteen years in a course for engineering students. Designed primarily for undergraduates in mechanical engineering; has features, the authors state, that should be of value in other departments. Has chapters on trusses and bents, expected to be useful to students in civil and in aeronautical engineering and chapters on cranes and machines.

HANDBUCH DES HOCHBAUES: Berechnung, Durch-Bilding und Ausfuhrung—Von Ing. Robert Schindler. Vienna: Julius Springer. Cloth; 6x9 in.; pp. 709; 906 illustrations in the text. 39 marks.

INTERNATIONAL ENQUIRY INTO COST OF LIVING: A Comparative Study of Workers' Living Costs in Detroit (U. S. A.) and Fourteen European Cities. Geneva, Switzerland: International Labor Office. London: P. S. King & Son. Boston, Mass.: World Peace Foundation, 40 Mount Vernon St. Paper; 6x9 in.; p. 209; tables. 7½s. in England; $2 in America.

Originated by a request to the International Labor Office from the Ford Motor Co., London, for relative costs of living in European cities in which the company already had or proposed to establish factories. After that office had supplied data in hand, the Twentieth Century Fund of Boston, Mass., offered to meet the cost of a special inquiry. Detailed studies were made of the living standards and costs of 100 families the heads of which were employed at $7 a day by the Ford concern in Detroit. These figures, with explanations, were sent to Europe and corresponding data, so far as feasible, were gathered in fourteen Continental cities. Both American and foreign data are given under similar heads (food, housing, insurance, taxation, etc.) There is also a brief comparative summary. Although the inquiry was made for a very special purpose and has as its American basis of comparison Detroit families under unusually favorable wage conditions, the exhibit and conclusions promise to be of much interest to many industrialists, economists and particularly to students of social problems.

LEISTUNGSVERSUCHE AN MISCHMASCHINEN—Von Prof. George Garbotz, Berlin, und Prof. Otto Graf, Stuttgart. Heft I, Mitteilungen des Forschungsinstitutus fur Machienwesen bein Bautrieb. Berlin: VDI-Verlag G.m.b.H. Paper; 8x12 in.; pp. 26; tables, halftones and line cuts, some on folding plates. 7.5 marks.

MEMORIA ADMINISTRATIVA Y DESCRIPTIVA de las Obras de la Carretera Central [Central Highway]. Havana: Secretary of Public Works. Four volumes. Paper; 7x10 in.; pp. 263, 269, 258, 344; many tables and illustrations, some on folding plates. Public document, to be obtained from the public-works department.

Two volumes consist of documentary and two of descriptive matter, the whole covering the period from the inception to the completion of the highway extending the length of the island. The American contractors for the road were Warren Brothers, Boston. Manuel A. Coroalles was chief engineer for the Cuban government.

MERITS OF TURBO-CHARGING OF DIESEL ENGINES—By Alfred J. Buechi, Winterthur, Switzerland. Abridgement of a paper read before Kikai Gakkai and Zosen Kyokai May-June, 1931. Paper; 9x12 in.; pp. 29; illustrations. For copies of the paper address the author, as above.

THE PARADOX OF PLENTY—By Harper Leech, with an introduction by Virgil Jordan. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 203; $2.50.

PREMINIER CONGRES INTERNATIONAL due Béton et du Béton Arme [First International Congress for Concrete and Reinforced Concrete 1930]. Second Edition. Liége, Belgium: La Technique des Travaux, 196 Rue Grety. Two volumes. Stiff paper; 10x13 in.; pp. 540 and 401; halftones and other illustrations, some on folding plates. $10.

A second printing of the many papers read before the congress on concrete held at Liége in September, 1930. The papers were presented in French, English and German, according to the country of each author, and are printed in like manner, but each is preceded by a brief summary in all three languages. Most of the papers are in French. Many branches of the main topic are dealt with. Some notable structures are described and well illustrated.

SAFETY IN THE HANDLING AND USE OF EXPLOSIVES—Pamphlet No. 17, published by Institute of Makers of Explosives, 103 Park Ave., New York City. Paper; 6x9 in.; pp. 63; line cuts. Free on application.

THE STORY OF NICKEL—By William H. Baldwin, Public Relations Counsel to the International Nickel Co., Inc. Paper; 6x9 in.; pp. 44; illustrations.

SURVEYING MANUAL: A Manual of Field and Office Methods for the Use of Students in Surveying—By William D. Pence, M.Am.Soc.C.E., Sometime Professor of Railway Engineering, University of Wisconsin, and Milo S. Ketchum, M.Am.Soc.C.E., Sc.D., Dean of College of Engineering and Director Engineering Experiment Station, University of Illinois. Fifth edition. New York and London: McGraw-Hill Book Co. Flexible; 5x8 in. pp. 363; illustrations. $2.50.

In this edition, which brings the total printing to 57,000, the preface states that "the text has been critically reviewed, the illustrations have been revised and engraved to a larger scale, and the entire book has been reset. The aim has been to train the student by means of a study of surveying rather than to teach the trade of surveying."

TABELLEN UND DIAGRAMME fur Wasserkamp: Berechnet aus der Spezifischen Warme—Bearbeitet von Osc. Knoblauch and others. Second edition. Munich and Berlin, Germany: R. Oldenbourg. Stiff paper, cloth back; 8x11 in.; pp. 40; folding diagram in pocket. 4.6 marks.

TESTS OF PLAIN AND REINFORCED CONCRETE MADE WITH HAYDITE AGGREGATES: A Report of an Investigation conducted by the Engineering Experiment Station, University of Illinois, in cooperation with the Western Brick Co.—By Frank E. Richart and Vernon P. Jensen. Paper; 6x9 in.; pp. 82; illustrations. 45c. from Engineering Experiment Station, University of Illinois, Urbana, Ill.

TOPOGRAPHIC SURVEY of the Upper Mississippi River and the Application of Aerial Photography to Map Work—By W. N. Brown, President W. N. Brown, Inc., Washington, D. C. Reprinted from the Baltimore *Engineer*, January, 1932. Paper; 8x11 in.; pp. 4.

THE USEFULNESS OF MATHEMATICS to Engineers—By P. W. Ott, Associate Professor of Mechanics. Circular 27, Engineering Experiment Station, Columbus, Ohio. Paper; 6x9 in.; pp. 15; illustrated.

THE USE OF MODELS IN THE SOLUTION OF INDETERMINATE STRUCTURES—By George E. Beggs, C.E., Professor at Princeton University, Princeton, N. J. Paper; 7x10 in.; pp. 12; photographs and line cuts.

WHAT 100 REPRESENTATIVE CITIES PAY FOR ELECTRIC LIGHT AND POWER UNDER MUNICIPAL OWNERSHIP: Rates in Effect 1931, With Brief Description Giving Output, Number of Services, Type of Power, Revenues, Expenses, Gross Profits and Valuation. Compiled by C. F. Lambert. Kansas City and Los Angeles: Burns & McDonnel Engineering Co. Paper; 6x9 in.; pp. 56; $1.

Besides the data indicated in the sub-title there is a table summary giving monthly costs per residence and commercial consumer for 50 and for 250 kw.-hr. consumption and the average income per kilowatt-hour generated. The data thus far mentioned are for cities in the United States. A small amount of information is given for twenty municipalities served by the Ontario Hydro-Electric Power Commission (Canada).

# *Letters to the Editor*

## Hand Labor Defended

Sir—Your editorial entitled "More Than a Shovel Buried," in the March 3 issue, is consistent with your previous policy in commenting on similar incidents where hand labor has been resorted to as a means of unemployment relief, but I do not believe it gives a very impartial view of the issue involved. You speak of "the grocer, the butcher and the clothier" who feel the "lowered spending power of the mechanics upon whom they depend for their livelihood," but you do not mention the added trade that the grocer, butcher and clothier get from the 100 new workers who may have previously been in actual want.

Without discussing the question as to whether or not the machine age is not actually responsible for much unemployment, a few moments' calculation will demonstrate that the labor cost for buying, operating and maintaining the steam shovel in question will be exceeded in less than a year by the use of equivalent hand labor. It is a more expensive means of excavation—of course—but surely as a temporary mode of helping relieve actual want there is a word to be said for it. The money spent on hand labor helps those who need it most and goes directly into circulation to buy the basic necessities of life.

After all, is the cheapest way always the best way? There are protests that public money is thus wasted in returning to primitive methods, but how would these sums spent on human welfare compare with the annual waste due to corrupt city administration?

Whatever the solution of the present business depression may be, it is not necessarily a forced return to the methods that broke down in 1929. It may possibly be good to try something different.

Bethlehem, Pa., March 7, 1932. BRUCE JOHNSTON.

# NEWS OF THE WEEK

## Denver Sells $400,000 Bonds "Over the Counter"

Denver, Colo., sold $400,000 worth of 4 per cent municipal building bonds "over the counter" at the city hall during the month of February. This is very encouraging for the city, following its failure to sell $2,500,000 of these bonds (funds to be used for completion of new city hall and court house now under construction) last summer. To relieve the situation then the mayor authorized the purchase, from municipal funds in banks, of $1,100,000 of the securities. Later the building fund ran out and the administration was forced to borrow $500,000 from the city water commission payable this spring. In order to repay the loan and raise more money to continue the building, the "over the counter" sale was started, the bonds being offered at slightly below par.

## Seattle City Officials Face Salary Cut

With the election of John F. Dore, on March 8, as mayor of Seattle, Wash., the city faces many changes in its government. Among Mr. Dore's campaign promises is slashing of salaries in excess of $3,000, including reduction of his own salary from $7,500 to $5,250.

Mr. Dore has announced that he will appoint Don Evans, former county engineer and now county commissioner of King County, city engineer, but at a salary of $5,250 instead of $8,000 which the position now pays.

J. D. Ross, superintendent of lighting, will be retained in office, but his salary will be reduced from $7,500 to $5,000.

## Low Road Costs Make Profitable Bonds Sold Below Par

Recently in St. Louis County, Missouri, $1,500,000 worth of bonds were sold for $27,750 below par, but according to the county engineer the money received from the bond sale will still build more concrete pavement than was planned when the bond issue program was adopted. Concrete pavement is now being built at costs which make the present dollar worth $1.60 compared with its value two years ago.

## German Construction Industry at 20 Per Cent

Decline of construction in Germany is shown by 1931 figures to be unusually severe. At the beginning of December only 20 per cent of the capacity of the construction industry was occupied, and the number of unemployed in the industry was estimated at 1½ million. As there has been no marked change in the situation during the early part of 1932, the figures may be taken as applicable today.

## Virginia Takes Over All County Roads In the State

A FORWARD STEP taken by the general assembly in Virginia is the taking over by the state of maintenance and construction of all county roads unless some of the counties exempt themselves from the act under the local option clause caused to be inserted in the bill by Gov. Pollard. This action will increase the mileage under state control from about 8,000 to about 40,000.

The state will take the gasoline tax now going to counties, and will supplement this with an additional appropriation of $2,000,000 from funds from the primary system for use on the secondary system of roads.

Cities, for the first time, will share in gasoline tax revenue, getting $2,000 a mile for streets traversed by highways.

## Holds Performance Bond for Material and Labor

The U. S. supreme court has sustained the ruling of the Mississippi courts holding that the Hartford Accident & Indemnity Co., which furnished a performance bond for the construction of a hotel at Natchez, is responsible for the debts incurred by the contractor for material and labor. Despite the contention of the bonding company that it was required only to guarantee the completion of the building and was not bound to satisfy the claims of subcontractors, the Mississippi supreme court held that the state law does not permit such an exemption.

In reviewing the matter, the United States supreme court has decided that no issue has been raised that would warrant reversal of the action of the lower court. The decree of the Mississippi court therefore has been confirmed.

## Favor Public-Works Expansion for Business Reconstruction

**Engineers join with economists in supporting unemployment relief by municipal construction at hearing before Senate committee**

IN HEARINGS on the La Follette public-works relief bill (Senate bill 2419) on March 9 to 11 before a Senate subcommittee at Washington, testimony was presented by engineers, economists, architects and contractors strongly favoring the proposal to maintain and increase public works by direct federal appropriation and by federal loans to cities and other local governments. The La Follette bill carries a 5½ billion dollar bond issue, of which 3¾ billion would be available under authority of a board to loan to local governments for public work. Other parts of the total fund would be applied to road construction and grade crossing work. The bill includes a provision for unifying the engineering construction work of the War Department, Navy Department, Reclamation Bureau, Supervising Architect and Bureau of Public Roads under an administrator of public works, for both normal and emergency purposes. The emergency appropriation, however, would cease to be available as soon as the index of industrial production reaches normal.

### Witnesses heard by committee

Witnesses included John Sloan, architect, New York; Sanford E. Thompson, engineer, Boston; John P. Hogan, engineer, New York; Malcolm Pirnie, engineer, New York; F. L. Cranford, contractor and banker, Brooklyn; R. C. Marshall, Jr., contractor, New York; Willard Chevalier, publisher director, and F. E. Schmitt, editor, *Engineering News-Record;* Prof. Willard L. Thorp, economist, Amherst College; Prof. W. H. Loucks, economist, University of Pennsylvania; M. S. Rukeyser, economist, Columbia University; W. J. McGrady, American Federation of Labor, Washington; A. L. Gayer, economist, Columbia University; and John A. Simpson, Farmers Union representative.

According to the economists a large program of public-works expansion is the best available means of checking price decline and creating new purchasing power under present conditions, and no difficulty should arise from the issuance of the bonds, especially if they are issued only as needed. Fears of disturbing the money and investment market are unwarranted, they stated.

### Bill would build confidence

Mr. Sloan decried the "obsession of balanced budgets," and asserted that the bill offers the only feasible device for bringing about reconstruction from the present disorganized industrial and commercial level. Congress has never had such opportunity as now, said Mr. Sloan, to build confidence and activity quickly from the present uncertainty.

Mr. Pirnie, after citing the recent survey of waterworks needs by the American Water Works Association, which showed opportunity for spending $500,000,000 on waterworks improvements to advantage, spoke of the hostile attitude taken by the Investment Bankers Association toward municipal bond issues, expressed in a resolution adopted

last summer, and the difficulty in selling bonds at reasonable rates that developed then, or soon afterward. He supported the proposal to assist cities in financing their public works.

### Much state work abandoned

Mr. Hogan said that at present about 35 per cent of municipal and state construction work has been abandoned and the progress of the movement in the same direction may lead to a total abandonment of 50 to 60 per cent. From this estimate and from the data furnished by the increasingly large number of engineers who are being assisted by the Professional Engineers Committee on Unemployment, he forecast the possibility of a large increase in unemployment due to construction. As an instance of the relation of construction, unemployment and relief he cited the recent cut of $21,000,000 in road construction by New York State and the immediately subsequent appropriation of $19,000,000 by the state for relief work. In order to make it possible to finance state and municipal construction projects he proposed, instead of the loan provision of the bill, a public corporation similar to the Reconstruction Finance Corp. to buy the securities of cities and hold them until they could be resold.

### Decrease in construction noted

This proposal was supported by Mr. Schmitt, who presented figures on the decrease in construction during the latter part of 1931 and the even more rapid decrease since then. On the basis of contract lettings during the first two months of 1932, he estimated that construction volume this year may drop to about half the 1931 volume unless present tendencies are soon reversed, and placed the additional unemployment due to reduction in municipal and state public-works projects at a million workers. He supported the principle of the bill, but considered the method of extending loans proposed by Mr. Hogan to be preferable under present conditions.

Mr. Cranford and Gen. Marshall also supported public works expansion as a necessary means of preventing a serious situation during the coming year. Gen. Marshall stated that conditions next winter are a matter of grave concern if no early and considerable expansion of business activity is brought about. He questioned the bond issue method of financing public works, but was not able to advance an alternative.

### Public works pay dividends

Col. Chevalier pointed out that the needs of the present situation are very pressing, and emphasized that public works pay dividends, while breadlines do not. He showed that because construction work serving the public welfare releases funds into the stream of general trade without increasing the pressure of goods on the market it is the quickest and least disturbing means of correcting the existing instability. Indorsing the bill as thoroughly sound, he pointed out that its value is quite the same for long-time stabilization as for the present emergency, and that the intelligent use of public works is a vital essential for continued success of the present capitalistic system of social economy.

Mr. McGrady cited the percentages of unemployed in various labor crafts, the high figure being 63 per cent for the building trades, as against 37 per cent for the metal trades and 31 per cent for all skilled trades. He looked for no marked increase in employment during 1932 and 1933, and predicted that next winter will see as many unemployed as last winter unless the government makes work. Asserting that the cost of unemployment is far greater than the cost of making employment, he expressed himself as out of sympathy with balancing budgets. Among public works or aid projects, he laid particular stress on loans to housing corporations.

## Large Public-Works Program Proposed in Seatttle

A $20,000,000 public-works program to increase employment in Seattle is contained in a proposal of a special committee of engineers and other technical workers, headed by Miles Clark, construction engineer, and now under consideration by the city council. A similar program of public works outside the city limits has been laid before the county commissioners by the same group.

The plan contemplates financing the work with an issue of twenty-year gold notes which would be acceptable for the payment of taxes and purchase of municipal and county bonds. These notes, according to the plan, would bear no interest. Sixty pending public-works projects within the city limits are encompassed in the plan, principally on streets and bridges.

The program, Mr. Clark said, is the product of several months' work by members of various Seattle technical societies.

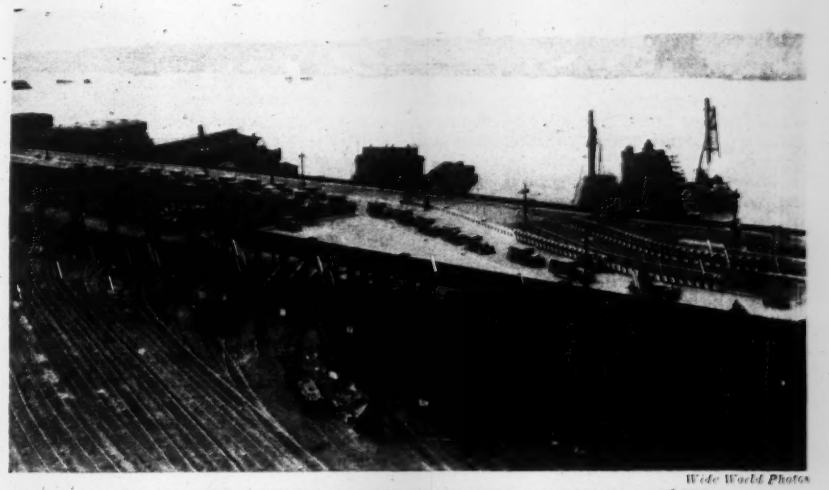
## Pennsylvania R.R. Asks Loan for Electrification Work

In order to continue the work of electrifying its line from New York to Washington the Pennsylvania R.R. has applied to the Reconstruction Finance Corp. for a three-year loan of $55,000,000. Because of conditions in the money market the railroad states that it will have to discontinue practically all work now under way unless it obtains the loan.

In addition to $47,000,000 required for the electrification work the railroad estimates that it needs for 1932 $2,000,000 for the Newark terminal work, $9,800,000 for its Philadelphia improvements, $1,500,000 for changes at Baltimore and $7,850,000 for miscellaneous work. It expects to be able to finance part of this expenditure without a loan. Work for 15,000 men will be provided by the proposed expenditures.

## To Work for Uniformity in Traffic Signs

Plans for developing complete uniformity in traffic signs, signals and pavement markings in both urban and rural districts were announced on March 17 by Secretary of Commerce Lamont, chairman of the National Conference on Street and Highway Safety, in naming representatives of the National Conference on Street and Highway Safety to cooperate with representatives of the American Association of State Highway Officials as members of a joint committee of the two organizations. The committee is known as the signs and signals committee. E. W. James, of the Bureau of Public Roads, is chairman.



*Wide World Photos*

**SECOND LINK OF NEW YORK'S ELEVATED HIGHWAY OPENED**

**The section of the express highway on the west side of New York, extending from 59th St. to 72d St. at Riverside Drive, was formally opened on March 9. This section eventually will be linked, by the construction of additional sections south of 59th St., to the section now in use between Canal St. and 23d St. The contract for the section from 23d St. to 38th St. has been let and work is expected to begin soon. Between 38th St. and 59th St. construction work has been held up because of problems connected with the proposed new 1,000-ft. ocean liner piers and the relocation of trunk sewers. The section just opened, from 59th St. to 72d St., is over the N. Y. C. R. R. 60th St. yard and was built by the railroad in repayment for land received from the city in excess of land conveyed to the city by the railroad in preparation for the reconstruction of the 60th St. yard. Contract for the superstructure was let by the railroad to James Stewart & Co.**

## Summer Management Course at Penn State

Pennsylvania State College has announced that its seventeenth annual summer course in management will be held June 8-16 under the auspices of the department of industrial engineering, with the engineering extension department cooperating. The faculty for the management course consists of men well trained in management by theory and by practical plant experience.

This summer course, inaugurated in 1915 by Hugo Diemer, yearly attracts many executives and foremen of all grades of education and plant experience. Topics this year include: industrial organization; principles, methods and applications of production control; trends in personnel management; principles of operation study; economic control of quantity and quality; standard costs; methods of industrial training; causes of budget failures; factory layout; and the development of executive ability.

## M.I.T. Is Subivided Into Five Departments

A new plan of administrative organization for the Massachusetts Institute of Technology was adopted at a meeting of the corporation on March 9. The new plan subdivides the institute for administrative purposes into five departments—school of science, school of engineering, school of architecture, division of humanities, and division of industrial cooperation. In addition, the new plan calls for the explicit recognition of the graduate school, embracing engineering, science and architecture.

Included in the school of engineering will be aeronautical engineering, building engineering and construction, business and engineering administration, civil and sanitary, chemical, electrical, electrochemical, fuel and gas, general, mechanical, mining and metallurgical, and naval architecture and marine engineering and naval construction.

The school of science, which will be under Dean Samuel C. Prescott, will include biology and public health, chemistry, geology, general science, mathematics and physics.

Architecture and architectural engineering will be administered under the school of architecture, with Prof. William Emerson as dean.

The new organization provides for an administrative council, an informal organization which will hold weekly meetings in order that all of its members may be kept fully informed of progress in various departments of the institute.

## Locomotive Crane Makers to Refuse Used Equipment

No allowance will be made for used equipment in the sale of new or used locomotive cranes, rail shovels or ditchers under terms of a resolution passed by the Locomotive Crane Manufacturers Association at a recent meeting in Chicago. The members of the association pledge themselves not to finance or assist directly or indirectly in the financing or disposal of used equipment in making new sales. The members will also prevent, as far as possible, their dealers and agents from assisting in the disposal of such used equipment in furtherance of sales of new locomotive cranes, shovels and ditchers. The agreement applies only to the sale of revolving locomotive cranes traveling upon rails, and rail shovels and ditchers. It will be in effect until Feb. 1, 1933.

## J. V. Neubert Elected Head of Railway Engineers

J. V. Neubert, chief engineer, maintenance-of-way, New York Central R.R., New York, was elected president of the

J. V. Neubert

American Railway Engineering Association at its annual meeting held in Chicago, March 15-16. He succeeds Lewis W. Baldwin, president, Missouri Pacific Lines.

Mr. Neubert is a native of Kittanning, Pa., and a civil engineering graduate of Pennsylvania State College, class of 1899. Since graduation from college Mr. Neubert's entire professional career has been with the New York Central. He began as a clerk in the engineering department and worked up to the position of supervisor of track in 1902. From 1905 to 1909 he was an assistant engineer, and then a division engineer on two divisions. In 1909 he was appointed engineer of track, a position which he held until, in 1920, he was appointed engineer, maintenance-of-way, New York Central Railroad-East. This position he held until his appointment in 1927 to be chief engineer, maintenance-of-way.

Mr. Neubert has been active in the affairs of the American Railway Engineering Association for many years.

## Port Arthur, Tex., Adopts City Manager Plan

The city manager form of government was adopted by Port Arthur, Tex., at an election on March 8. Returns from six of the eight boxes gave returns of 5,285 in favor of the new charter and 1,691 against.

# *Washington Notes*

By Paul Wooton
*Washington Correspondent*

THE payment of prevailing-wage r in the construction of dams, in the provement of rivers and harbors and flood-control work would be required government contractors under the pr sions of legislation that has been drafted a special subcommittee of the House la committee. This legislation will be sidered by the full committee in the future and favorable action is expec The existing prevailing-wage law app only to the construction of buildings the federal government.

Realizing the difficulty of determinin basis for establishing the prevailing-w rate for field work, the subcommittee specified that the minimum rate must be less than the cost of living in the c munity concerned. The secretary of la is empowered to determine what constitu the cost of living in case of a disp The bill also will prohibit construct work on Sundays and holidays except emergencies. It is the intention of committee that the measure shall apply work done directly by the government day labor as well as to work let und contract.

While not opposed to the principle of prevailing-wage rate requirement, the w department has indicated that it would pr fer to have the determination of the mi mum rate left to its own officials rath than to some other government departm In testimony before the committee, Maj Gen. Brown, Chief of Engineers, expres the opinion that the secretary of lab cannot be expected to be as familiar wit conditions as the department concerned. I contractors on river work refuse to ado the right policy toward their labor, Ge Brown would do subsequent work wit government plant if it should develop th such undesirable contractors are lo bidders.

### Emergency Road Bill

As this is written it is being predicte that the emergency road bill will be passe by the Senate. While final action on th measure probably will not be taken thi week, a vote may come any day. It is ex pected that the amendment by Senato Bingham, of Connecticut, will be voted down. That amendment would allot th emergency fund on a basis of population Its effect, opponents declare, would be t disrupt the whole plan of federal aid. Th distribution of the money was worked ou after long and careful study and in practice has proved very satisfactory, it is con tended. There is every reason to believe that the emergency bill, if passed, will be vetoed. Its friends, however, claim that it can be passed over the veto.

### Ring Levee at Monroe, La.

A ring levee 25 miles in circumference probably will be built by the federal gov ernment to protect Monroe, La., from the floodwaters of the Mississippi. An under standing to that effect was reached betwee the authorities at Monroe and Major Gen Lytle Brown, Chief of Engineers, during Gen. Brown's recent visit there. While the details of the proposed construction at Monroe are still to be worked out, Gen Brown is convinced that none of the ob

stacles in the way is insurmountable. The chief difficulties will be encountered in the securing of right-of-way for the levee and in making it certain that the federal government will incur no liability.

## Hoover Dam Notes

Progress of 412 ft. was made in driving 41x56-ft. headings in the Hoover Dam diversion tunnels during the week ended March 5. A total of 1,331 ft. of 15-ft. bottom bench was removed during the same period. Trimming operations preparatory to concreting totaled 1,783 ft. The status of tunneling operations to March 5 is shown in the following table:

| Tunnel | Length | Sec. | Week's Total | Progress to Date Inlet | Outlet | Total |
|---|---|---|---|---|---|---|
| No. 1 | 4,301 | H | 326 | 1,145 | 1,941 | 3,026 |
| | | B | .... | 324 | .... | 324 |
| | | T | | | | |
| No. 2 | 3,879 | H | (Holed through Feb. 3) | | | 3,879 |
| | | B | 426 | 558 | 221 | 779 |
| | | T | 620 | 1,008 | 531 | 1,539 |
| No. 3 | 3,560 | H | (Holed through Jan. 31) | | | 3,560 |
| | | B | 605 | 820 | 540 | 1,360 |
| | | T | 450 | 1,070 | 630 | 1,700 |
| No. 4 | 4,166 | H | 85 | 1,817 | 2,349 | 4,166 |
| | | B | 300 | .... | 450 | 450 |
| | | T | 713 | 463 | 652 | 1,115 |
| All | 15,905 | H | 411 | .... | .... | 14,691 |
| | | B | 1,331 | .... | .... | 2,913 |
| | | T | 1,783 | .... | .... | 4,354 |

H - 41x56-ft. enlarged heading; B - 15-ft. bottom bench; T - trimming.

* * *

Excavation for the inlet portal of tunnel No. 2 was completed March 4. The concreting of the portal structure was started the following day. Due to the depth of mud at the tunnel outlets very little progress is being made at these locations.

* * *

In the inclined spillway tunnels the 7x10-ft. top headings are in 392 ft. in the Nevada tunnel and 212 ft. in the Arizona tunnel. The rock at the bases of the Nevada intake towers is being drilled. The Six Companies screening plant was shut down during the week while extensions were made to track hoppers and equipment. Loading of gravel at the pit was continued and shipments were made to a raw storage dump near the screening plant. The mixing plant was operated March 5 to provide concrete for cofferdams at tunnels No. 1 and No. 4 and for the trash rack foundation at the inlet of tunnel No. 2.

* * *

The project offices were moved into the new administration and municipal buildings at Boulder City Feb. 29. Specifications have been issued for 30 temporary frame three-room residences. Bids will be opened March 28. Filtered and treated water was pumped from the filtration plant to the storage tank for the first time March 2. The plant has been operated continuously since that time.

## Georgia County Votes Bonds for Public Works

The voters of Fulton County, Ga., of which Atlanta is the county seat, have voted a $700,000 bond issue, the vote being 10,243 for and 1,400 against. Ratification of the bond issue insures a building program that will put about 500 men to work on construction of fifteen new school houses and ten annexes, and enlarging several of the present school buildings.

# Rubber Discussed By A.S.T.M. At Cleveland

THE history of rubber from its earliest use, but more particularly since the accidental discovery of the vulcanizing process by George Goodyear almost a hundred years ago, formed the subject of the technical sessions at the regional meeting of the American Society for Testing Materials in Cleveland March 9. Five papers discussed the manufacture of rubber products, and seven papers dealt with the properties of rubber as an engineering material. In addition to the all-day session on March 9, several important committee reports were offered, various committees and subcommittees having met all week.

### Industry gaining impetus

In almost all the papers and in what little discussion of papers there was, emphasis was placed on the fact that the technology of rubber products manufacture is now receiving its greatest impetus. Many papers also referred to the growing knowledge in the use of latex, particularly for consumer products. Latex is the raw rubber as taken from the tree. About 60 per cent of it is water, and of the twoscore or more chemical constitutents it contains, 93 per cent are the rubber hydrocarbons. Latex is now being made into a wide variety of products and suffers little deterioration through age since it is neither calendered (which destroys the molecular structure) nor compounded with the reinforcing materials familiar to vulcanized products to produce high ultimate strength.

One of the most practical of the papers was that one prepared by H. E. Fritz and J. R. Hoover, of the Goodrich Rubber Co. This paper summarized the industrial uses of rubber in resisting chemical action, and detailed the resistance of 83 inorganic acid solutions, solutions of salts and alkalis (including nine plating materials) and organic materials, including many food products heretofore considered difficult to handle. Mr. Hoover reported the recent completion of a 32,000-gal. tank car for the handling of dilute sulphuric acid under pressure.

### Rubber as an engineering material

Also important among the papers discussing rubber as an engineering material was the one presented by R. K. Lee, Chrysler Corp. Mr. Lee's paper, read by one of his associates, emphasized the fact that the automobile industry has been greatly hampered in its use of rubber to resist both shock and vibration because of a popular belief that rubber deteriorates much faster than the metal with which it is in contact. He reported that but two automobiles sold by his company had been returned because of unsatisfactory rubber motor mountings. He also reported that, if properly prepared, rubber would indefinitely resist deterioration through contact with oil, thereby refuting one popular motion.

In a paper on crude and reclaimed rubber read by R. H. Gerke, of the development department of the U. S. Rubber Co., Mr. Gerke asked that it be thoroughly understood that reclaim was used as a compounding material and not as an adulterant. He reported that the use of reclaim had so grown during the past decade that in 1928 half the rubber used was crude and half reclaim, and that the ratio even now was 35 per cent.

The principal speaker at the dinner meeting which ended the symposium was a member of the Goodyear-Zeppelin Corp., who read a paper prepared by Dr. Karl Arnstein, vice-president of engineering.

Important committee action included the presentation of (1) a method of making freezing and thawing tests for concrete; (2) a purchase specification for ready-mixed concrete (both from committee C-9); a method for making tension tests on metal tubing of all sizes (E-1); a new specification for cast-iron culvert pipe (A-3). Two papers were recommended by committee C-9 for presentation at the annual convention; one on the action of waters on concrete by B. Kellam, Hydro Electric Power Commission of Canada; and one by E. W. Bauman, engineer of tests of the Tennessee highway commission, reporting numerous field tests on concrete structures. Committee A-2 on steel announced preparation of a new specification on electric-fusion welded pipe in sizes up to 30 in. diameter and took action to authorize the preparation of test methods for wire and wire rope. The need for a specification covering wires and cables for suspension bridges was referred to the subcommittee on structural steel for bridges.

## Work Found for 1,000 Engineers by New York Relief Committee

Temporary relief work for 1,090 men has been found by the Professional Engineers Committee on Unemployment in the New York metropolitan district, including Westchester and Nassau counties and metropolitan New Jersey. The total value of the relief work found, in terms of wages paid together with the value of clothing contributed and separate contributions for administration, now amounts to more than $270,000. Direct contributions in cash or pledges to the committee amount to $94,600.

Of the men placed to date only a few more than half are members of the national engineering societies; 144 are civil engineers, 144 electrical, 219 mechanical, and 42 mining engineers. On the other hand, contributions to date have come almost entirely from members of the four major societies.

Contributions of clothing are needed by the committee, especially warm clothing for men on outside work. A depot has been established in the McGraw-Hill Building, 330 West 42d St., for the receipt and distribution of clothing.

## License Law Bills Passed by New York Legislature

Bills to amend the New York state education law as it affects the practice of engineering and of architecture were passed by both houses of the New York state legislature before it adjourned on March 11. The bills are now before the governor for his consideration. The two bills make numerous changes to clarify the wording of the laws, to eliminate sources of conflict between the two professions and to simplify administration of the laws.

## Large Concrete Chimney

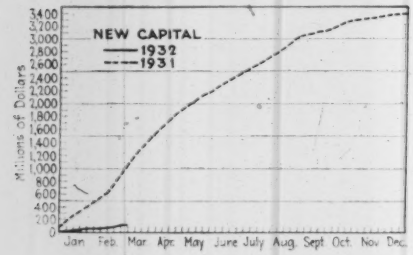
A monolithic reinforced-concrete chimney 492 ft. high with inside diameter of 18 ft. at the top was recently built at the Neuhof powerhouse in Hamburg, Germany. It is one of the highest concrete chimneys ever constructed.

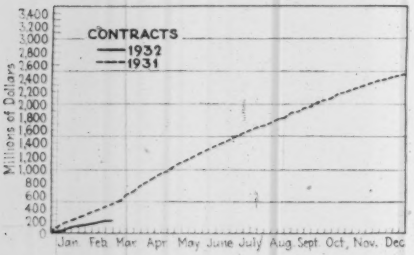
## Capital and Contracts

Issues of new capital for the week ended March 12 reached a total of $20,000,000, compared with $15,000,000 for the preceding week and $146,000,000 in the corresponding week of 1931.

Public bond issues accounted for $9,000,000 of the total for the week of March 12, against $6,000,000 for public work in the preceding week.

Cumulatively, the total for the period Jan. 1 to March 12, inclusive, is $128,000,000, compared with $910,000,000 in the corresponding part of 1931.




## COSTS AND CONTRACTS

### *ENR Index Numbers*

| | Cost | | | Volume | |
|---|---|---|---|---|---|
| **March,** | **1932** | **157.21** | **Feb.,** | **1932** | **105** |
| Feb., | 1932 | 161.82 | Jan., | 1932 | 121 |
| March, | 1931 | 194.51 | Feb., | 1931 | 198 |
| Average, | 1931 | 181.35 | Average, | 1931 | 220 |
| Average, | 1930 | 202.85 | Average, | 1930 | 260 |
| 1913 | | 100.00 | 1913 | | 100 |

### *This Week's Contracts*

Heavy construction contracts, reported by *Engineering News-Record* in the week of March 17, with some comparisons, total as follows:

(In Thousands of Dollars)

| | Mar. 17, 1932 | Average of Last Four Weeks 1932 | 1931 |
|---|---|---|---|
| Buildings | | | |
| Industrial | $1,113 | $863 | $4,421 |
| Other | 11,901 | 6,052 | 14,190 |
| Streets and roads | 1,843 | 2,869 | 11,877 |
| Other construction | 6,675 | 7,136 | 28,501 |
| Total | $21,532 | $16,921 | $58,991 |

Total, all classes, Jan. 1 to Mar. 17:
1932 ..... $213,981
1931 ..... 617,024

## Investigating Water Supplies of New York State

Complete data as to the availability of potable water supplies in New York State is being compiled by a special legislative committee, which has filed a preliminary report with the legislature. With the cooperation of the U. S. Geological Survey, the committee has prepared maps and tables showing the amount of rainfall for every section of the state as well as all streams and their watersheds. Water systems in operation, both private and public, have been studied as to source of supply, treatment of water, population served, consumption and storage capacity. In its preliminary report the committee states that its final report will serve as a guide to the legislature in the formulation of a broad water-supply policy and the proper regulation of the water supplies of the state.

## Concrete Pavement Yardage

Below is a tabulation of concrete pavement yardage awarded in the United States during the month of February, divided according to roads, streets and alleys, and the totals for the two months' period ended Feb. 27:

| | During February | To Feb. 27 |
|---|---|---|
| Roads | 3,083,876 | 5,335,924 |
| Streets | 170,857 | 404,991 |
| Alleys | 108 | 38,139 |
| Total | 3,254,841 | 5,779,054 |

## SOCIETY CALENDAR

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, June 20-24.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Yellowstone National Park, July, date to be fixed.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Memphis, Tenn., May 2-6.

AMERICAN WELDING SOCIETY, annual meeting, New York City, April 27-29.

NEW ENGLAND SEWAGE WORKS ASSOCIATION, annual meeting, Boston, April 25.

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CANADIAN BRANCH, American Water Works Association, at its annual convention at Niagara Falls, Ont., elected as president W. E. MacDonald, waterworks engineer, Ottawa, Ont.

INDIANA SECTION, American Water Works Association, met March 9-10 at Purdue University, Lafayette. Some of the bread-and-butter subjects discussed were valve and hydrant inspection, meter-reading methods, meter damage, pressure in services, cross-connections, elevated storage, fire protection and management problems. Along purification lines subjects scheduled included definition of a satisfactory water, filter sand maintenance, chlorine control and interpretation of laboratory results to plant operation.

LITTLE ROCK (ARK.) ENGINEERS CLUB at its March meeting elected officers as follows: president, George D. Suter; vice-president, Florance J. Donahue; secretary-treasurer, W. Terry Feild.

MID-SOUTH SECTION, American Society of Civil Engineers, will hold its annual convention in Little Rock, Ark., late in April or early in May.

NEW YORK STATE HIGHWAY CHAPTER. Associated General Contractors of America, at its annual meeting in Utica on March 9-10, chose as president George N. Chambers, of Rochester.

SAN DIEGO ENGINEERS' CLUB at its annual election chose the following officers: president, B. D. Phelps; vice-president, E. L. Freeland; secretary, H. H. Allen; treasurer, Harry Haelsig.

# *Personal Notes*

W. COMPTON WILLIS, chief deputy engineer of the water department of Wilmington, Del., has been appointed chief engineer, succeeding S. Newbold Van Trump, who will take the position of assistant engineer until June 1, when his connection with the department will cease.

O. D. CONOVER, for the last three years vice-president of the Foundry Equipment Co., Cleveland, and during the preceding ten years foundry specialist and assistant chief engineer of the Austin Co., Cleveland, has opened an office for the practice of consulting engineering in Cleveland. He will specialize in the development, layout and design of industrial plants and foundries.

# *Obituary*

HERMANN FOUGNER, of Larchmont, N. Y., died on March 9 as the result of a fall in January. Mr. Fougner, who was 55 years old, was born in Norway, and was graduated from the Technical School at Trondkhen in 1895, coming to this country soon thereafter. Mr. Fougner was prominent in concrete and structural steel design and construction, and served various organizations in technical and executive capacities. He was with Milliken Brothers, New York City, for a number of years, serving not only in the New York City but in Port Arthur, China, where, as engineer, he superintended the erection of the extensive steel construction at the imperial Russian navy yard. He was also the sole representative of Milliken Brothers in the Far East. Later he was, at various times, vice-president of the Thompson-Starrett Co., New York City, vice-president and director of Thompson & Binger, Inc., New York City, and president and chief designer of the Fougner Steel Co., New York City, which company he founded.

ROBERT VAN DEUSEN, formerly a locating engineer on many railway projects in this country and more recently county surveyor of Tazewell County, Ill., died at Pekin, Ill., on Jan. 15. Mr. Van Deusen was a native of Kinderhook, N. Y., and while he was a boy his family moved to Illinois, where at the age of fifteen he began survey work as a flagman on the D.U.B.&P. (now Big Four Ry.) in October, 1868. In subsequent years he served as locating engineer on many railway lines in the Central and Western states.

FRANK WINNER RUSSUM, construction engineer, died on March 11 at his home in Larchmont, N. Y., at the age of 50. Among the undertakings he directed as an engineer were the Jefferson County Bank Building, Birmingham, Ala.; the railroad terminal at Nashville, Tenn.; the gunpowder plant of the du Pont company at Carneys Point, N. J.; and the Hotel du Pont at Wilmington, Del. In 1918 Mr. Russum organized the Frank W. Russum Co. with offices in Detroit and New York.

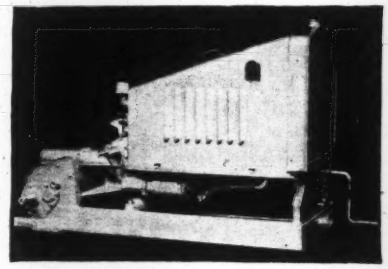
HARRY F. OSTRANDER, president of the Pioneer Sand & Gravel Co., of Seattle, Wash., died on March 5, at the age of 57 years.

# Construction Equipment and Materials

## Heavy Diesel and Light Power Unit New Products of Waukesha

A six-cylinder diesel engine of 200 hp. was shown by Waukesha Motor Co., Waukesha, Wis., for the first time at the recent Road Show. It is a four-cycle, solid injection unit with Bosch injection pump and fuel system. A special compressed air starting system is included, replacing the gasoline auxiliary starting system used on previous four-cylinder models. This engine is complete with fuel, air and lubrication filters.

For truck-mixing units, Waukesha has introduced a special power plant available



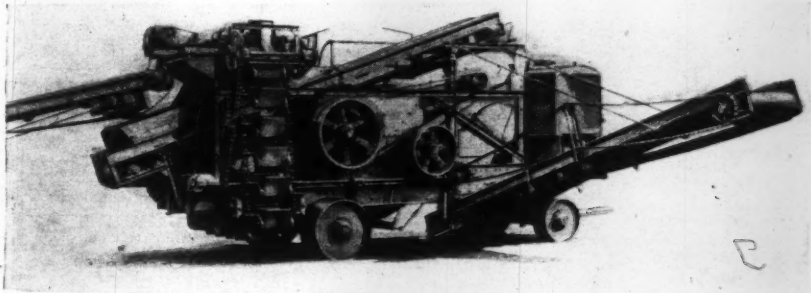
Special power unit for truck mixer.

in sizes ranging from 15 to 35 hp., completely mounted as a unit with a right-angle reduction and reverse gear and heavy-duty clutches. The unit has a 14:1 reduction, which, through jaw clutches, also serves as a reverse.

## Portable Crushing Plant

To meet the growing demand for larger capacity units capable of reducing rock and pit run gravel to smaller sizes, two new Western portable crushing and screening plants have been developed by the Austin-Western Road Machinery Co., 400 North Michigan Ave., Chicago. The two new models, known as No. 100 and No. 90, are compact and readily portable. The over-all height is under 12 ft., the over-all length, exclusive of pit conveyor, is under 26 ft., and the over-all width, exclusive of the delivery conveyor, is less than 10 ft. The two models are identical except that the No. 100 plant contains both primary and reduction crushers and the No. 90 plant contains but one crusher. A two-deck screen is used in the No. 100 machine and a single-deck screen in the No. 90. When moving from one location to another it is necessary only to disconnect the pit and delivery conveyors. The machines do not project below the ground level at any time, and it is not necessary to dig a pit for the lower end of the delivery conveyor or the bucket carrier which returns the crushed material to the screen. The plants can be operated by separate power units but are designed to accommodate self-contained units for driving the entire plant. Where it is desired to load the finished product directly into trucks, a 20-ft. delivery conveyor is furnished, a 2½-yd. storage hopper allowing the material to accumulate while a loaded truck pulls away and an empty one takes its place.

Western portable crushing and screening plant.



## Business Notes

BLAW-KNOX CO., Pittsburgh, and the Western Pipe & Steel Co., of San Francisco and Los Angeles, have closed an agreement whereby Western Pipe & Steel will manufacture Blaw-Knox products on the Pacific Coast and will sell through the organization of a new company to be known as Blaw-Knox & Western Pipe Corp. This new concern will be owned equally by the two companies.

HARNISCHFEGER CORP., Milwaukee, has acquired the manufacturing rights for the Hansen arc welder. The Hansen welder was developed by the Northwest Mfg. Co., and has been manufactured and marketed by that concern for some years. Klaus Hansen, inventor of the Hansen welder, has joined the staff of the Harnischfeger Corp.

INTERNATIONAL NICKEL CO., Inc., has appointed R. L. Suhl manager of the nickel sales department, succeeding the late Frederick S. Jordan. Ransom Cooper, Jr., Walter C. Kerrigan and Charles McKnight have been appointed as Mr. Suhl's assistants.

LAMB TRACTOR CO. has been organized for the manufacture of SpeedTrak tractors as a separate unit of the Lamb-Grays Harbor Co., Hoquiam, Wash. Frank H. Lamb, a partner in the parent company, will be president of the new company.

SPEEDER MACHINERY CORP., Cedar Rapids, Iowa, has placed its management and control in the hands of an executive committee composed of Sutherland Dows, Howard Hall, G. T. Ronk, Donald McMurray and Ronald Monroe.

THE MAXIM SILENCER CO., Hartford, Conn., has established as an addition to its regular business a consulting service which will specialize in the solution of noise problems. It is headed by Dr. Hiram Percy Maxim, inventor of the Maxim silencer, and will have at its disposal the services of the entire engineering and research staffs of the company.

## New Equipment in Brief

*Drill Sharpener*—The Gardner-Denver Co., Quincy, Ill., has increased its series of drill steel sharpeners with the introduction of the Model DS-6, a larger and more powerful sharpener. Equipment can be supplied for handling any size of hexagon, quarter-octagon or round steel. Double taper bits up to 3 in. on steel up to and including 1¾ in. round can be forged and sharpened. The machine incorporates a new and distinctive scale blower operated by a small lever within easy reach of the operator.

*Locomotives*—The Plymouth Locomotive Works of the Fate-Root-Heath Co., Plymouth, Ohio, has developed a complete line of diesel, gas-electric and oil-electric locomotives from 6 to 80 tons in weight. Three new models have been added to the diesel line, a 6-ton equipped with three-cylinder 36-hp. engine, an 8-ton equipped with four-cylinder 48-hp. engine, and a 10-ton equipped with a six-cylinder 72-hp. engine. These locomotives are equipped with Cummins diesel engines. The gas-electric and oil-electric models are built in center type high or low cabs, or end type cabs, with either double or single control stations and single or double power units.

*Deep Well Pumps*—A complete line of shallow and deep well automatic electric water systems and pumps has been placed on the market by the Westinghouse Electric & Mfg. Co., Pittsburgh, Pa. These units have been on the market for two years, but improvements have been effected resulting in a newly designed line of entirely automatic pumps. The new deep well heads comprise a 4-in. and 8-in. stroke. Features of the new pumps are malleable iron base, roller-bearing main shaft, and the construction of the pump bases, water box and differential conveniently arranged, affording ready access to sucker rods and cylinder parts without disturbing other parts of the installation.

## New Publications

*Motors*—Wagner Electric Corp., 6458 Plymouth Ave., St. Louis, Mo., has issued a new 22-p. bulletin on squirrel-cage motors, bulletin 174. The bulletin describes seven types of squirrel-cage motors, gives application tables, speed-torque curves, and complete construction details. It is in loose-leaf form to permit keeping it up to date at all times.

*Bituminous Road Equipment*—A new 20-p. catalog No. 22, issued by the White Mfg. Co., Elkhart, Ind., describes the complete line of Chausse-White portable equipment for all kinds of bituminous paving work, either hot or cold laid, now manufactured by the White company but formerly sold by the Chausse Oil Burner Co. Portable asphalt and steam repair plants are featured, along with complete road mix pavers and central paving material mixers built up of Chausse-White portable pug mixers used in combination with standard elevating loaders and a mechanical spreader or road finisher.

*Track Equipment*—The G.E.O. type of railroad track equipment, its advantages and application, are described in a well-illustrated 32-p. bulletin No. 2 of the Carnegie Steel Co., Pittsburgh, Pa.

*Diesel Engine Indicators*—Bulletin No. 3256 published by the Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa., describes recent developments in the line of Maihak engine indicators for the testing of compression of diesel engines.

*Arc Welders*—General Electric Co., Schenectady, N. Y., describes six different types and sizes of portable arc-welding machines in its new bulletin GEA-1543.

# Current Construction Unit Prices

## Railroad Grade Elimination at Niles, Ohio

AN EXTENSIVE grade-crossing elimination project is under way in Niles, Ohio, from West Second St. to West State St., over the Mahoning River and the tracks of the Pennsylvania R.R. Bids were received Feb. 2 by the board of commissioners of Trumbull County from 29 contractors and contract was awarded for $278,255. Two bids were out of line with the others; the average of 27 bids was $319,661; engineer's estimate, $373,410.

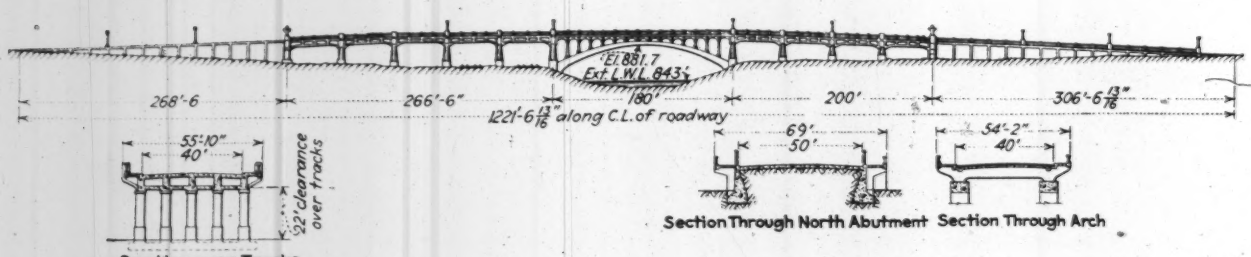
Principal items in order of cost are: structural steel, $26,775; girder and deck concrete, $25,438; reinforcing steel, $23,100; pier and abutment concrete, $23,000; cement, $22,950; excavation, $16,200; the six items comprise half of the total cost.

In addition to building the new reinforced-concrete and structural steel structure, 1,220x70 ft., the work comprises (1) building temporary crossing for highway vehicular and pedestrian traffic over river and tracks; (2) removal and disposal of the foundations and single-truss span of the existing bridge on South Main St.

The unit prices for concrete do not include the cement or reinforcing steel, which are separate items. Lowest price submitted for the 15,000 bbl. was $1.27; contract price, $1.60. Lowest price for reinfocing was 2.3½c.; contract price, 2.8c. Concrete for footings is 1:6½ with minimum strength 3,000 lb.; for piles, 1:4½; for gunite, 1:3; for railing, 1:1½:2½; for piers and abutments, arch ring, girder and deck, paving and stairs, 1:5½, with minimum strength of 3,600 lb.

The open concrete arch is 180-ft. span and rises 37 ft. above normal water level, 22 ft. above ordinary high water. Contract price of the 600 cu.yd. of arch ring concrete was $18.90. There were thirteen lower bids on this item, averaging $15.32 per cubic yard. Unit prices are given of the lowest four bidders: (A) E. H. Latham Co., 447 Neilston St., Columbus, contract; (B) Dawson & Finan, Cleveland; (C) A. Phelps & Sons, Detroit; (D) Industrial Construction Co., Cleveland. Wendell P. Brown, 750 Prospect Ave., Cleveland, is engineer and architect.

| | A | B | C | D |
|---|---|---|---|---|
| General conditions and special requirements (lump sum) | $1,735.000 | $1,872.500 | $330.000 | $1,174.500 |
| Temporary crossing (lump sum) | 1,064 800 | 990,950 | 1,436,700 | 892.300 |
| Excavation (including backfill), 8,100 cu.yd | 2.00 | .45 | 4.00 | 1.95 |
| Cement, 15,000 bbl | 1.53 | 1.27 | 1.60 | 1.34 |
| Footing concrete, 2,800 cu.yd | 3.95 | 6.20 | 5.00 | 5.78 |
| Pier and abutment concrete, 2,500 cu.yd | 9.20 | 16.75 | 13.00 | 12.95 |
| Arch ring concrete, 600 cu.yd | 18.90 | 14.64 | 14.00 | 22.70 |
| Girder and deck concrete, 1,850 cu.yd | 13.75 | 9.40 | 13.00 | 14.75 |
| Flat slab concrete, 1,050 cu.yd | 9.50 | 8.50 | 9.00 | 8.20 |
| Concrete for steel protection (gunite), 1,250 cu.ft | 1.70 | 1.65 | 1.50 | 1.82 |
| Concrete for stairs, 120 cu.yd | 28.50 | 48.00 | 18.25 | 20.00 |
| Concrete for railing (panels), 1,100 lin.ft | 7.10 | 6.50 | 6.00 | 8.00 |
| Concrete for pylons, lamp and railing posts, 2,550 cu.ft | 2.75 | 3.30 | 3.00 | 3.85 |
| Concrete slab for pavement base, 420 cu.yd | 6.10 | 4.50 | 5.00 | 6.00 |
| Concrete sidewalk (on fill), 3,200 sq.ft | .14 | .22 | .10 | .20 |
| Concrete piles, 10,300 lin.ft | 1.56 | 1.40 | 1.60 | 1.48 |
| Reinforcing steel, 825,000 lb | .028 | .025 | .0315 | .026 |
| Structural steel (incl. castings), 850,000 lb | .0315 | .0335 | .03 | .0338 |
| Reinforcing mesh (for pavement base), 2,600 sq.yd | .25 | .23 | .33 | .20 |
| Safety treads, 250 sq.ft | 1.00 | 1.10 | 1.00 | 1.25 |
| Copper for expansion joints, 3,200 lb | .32 | .30 | .28 | .25 |
| Rubber compression plates, 230 sq.ft | .30 | .75 | .85 | .75 |
| Pipe railing exclusive of posts, 900 lin.ft | 2.90 | 2.40 | 2.00 | 2.70 |
| Metal drains and fittings, 18,000 lb | .0825 | .05 | .05 | .055 |
| Metal conduits for lighting, a 1¼-in. diam., 300 lin.ft | .25 | .38 | .15 | .18 |
| Metal conduits for lighting, b 2-in. diam., 2,300 lin.ft | .35 | .43 | .20 | .24 |
| Fiber conduits (for power cables), 5,000 lin.ft | .22 | .25 | .20 | .24 |
| Lighting units and fittings, type A, 16 each | 99.00 | 110.00 | 125.00 | 121.00 |
| Lighting units and fittings, type B, 18 each | 92.50 | 100.00 | 125.00 | 121.00 |
| Waterproofing, type A, 37,000 sq.ft | .043 | .05 | .044 | .04 |
| Waterproofing, type B, 40,000 sq.ft | .16 | .137 | .120 | .15 |
| Brick pavement, (a) 3-in. brick, 3,500 sq.yd | 1.65 | 2.00 | 1.00 | 1.50 |
| (b) 4-in. brick, 2,700 sq.yd | 2.00 | 2.10 | 1.25 | 1.90 |
| Concrete pavement and curb, 155 cu.yd | 7.70 | 10.00 | 6.25 | 10.00 |
| Granite curb, (a) Straight on structure, 1,860 lin.ft | 1.50 | 1.75 | 1.59 | 1.85 |
| (b) Curved on structure, 60 lin.ft | 1.70 | 1.90 | 1.80 | 2.10 |
| (c) Straight on approaches, 560 lin.ft | 1.53 | 1.70 | 1.55 | 1.80 |
| (d) Curved on approaches, 60 lin.ft | 1.75 | 2.00 | 1.77 | 2.20 |
| Curb inlets, 4 each | 64.00 | 16.50 | 26.50 | 25.00 |
| Drainage manholes, 9 each | 106.00 | 70.00 | 95.00 | 150.00 |
| Vitrified pipe drains, (a) 6-in. diam., 250 lin.ft | .40 | .75 | .20 | .25 |
| (b) 8-in. diam., 625 lin.ft | .54 | .80 | .30 | .35 |
| (c) 10-in. diam., 10 lin.ft | .70 | 1.00 | .50 | .45 |
| (d) 12-in. diam., 260 lin.ft | .83 | 1.10 | .60 | .50 |
| (e) 15-in. diam., 500 lin.ft | 1.16 | 1.25 | .90 | .65 |
| (f) 18-in. diam., 10 lin.ft | 1.70 | 2.00 | 1.50 | 1.50 |
| (g) 24-in. diam., 10 lin.ft | 2.60 | 2.50 | 3.00 | 2.50 |
| Slag fill (abutment approaches), 2,400 cu.yd | 1.20 | 2.75 | 1.00 | 1.00 |
| Totals | $278.255 | $281.170 | $284.430 | $286.457 |




Elevation and cross-sections concrete and steel grade elimination at Niles, Ohio.